



September 25, 2007

Linda Jacobson (3 Copies)
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1595 Wynkoop Street
Denver, Colorado 80202-1129

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Office of Enforcement
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RE: 2007 Interim Measures Work Plan Addendum - Speiss-Dross and Thaw House Areas Soil Sampling, Excavation, Confirmatory Sampling, and Interim Capping Work Plan - Asarco East Helena Plant

Dear Ms. Jacobson,

I am enclosing the 2007 Interim Measures Work Plan Addendum, Speiss-Dross and Thaw House Areas Soil Sampling, Excavation, Confirmatory Sampling, and Interim Capping Work Plan, along with the certification signed by an officer of ASARCO LLC, under the East Helena Consent Decree. This Work Plan replaces the Speiss-Dross and Thaw House Cleaning, Demolition, and Soil Sampling Work Plan, which was submitted on September 12, 2007. The replacement Work Plan incorporates revisions discussed in a September 17, 2007 conference call between Asarco, EPA and the Montana Department of Environmental Quality. A copy of the 2007 Interim Measures Work Plan Addendum is simultaneously being submitted in the enclosed compact diskette.

On September 6, 2007, URS/CWC commenced cleaning and demolition in the speiss-dross area. Most of the structures associated with the cleaning and demolition have been removed. In accordance with EPA's September 19, 2007 approval, URS/CWC has removed the excess soils leading to the highline railroad. URS/CWS has been instructed not to begin any sub-surface soils removal until Asarco receives EPA's approval to the attached Work Plan.

We look forward to EPA's prompt review and approval of the work plan. Depending upon when work can be initiated, the work sequencing and weather conditions, the placement of the interim capping may be performed prior to removal of subsurface soils in exposed areas. In this case, the final cleanup of material and associated impacted soils within the cleaning and demolition footprint would be conducted in the 2008 construction season. Please contact me if you have any questions concerning the work plan.

Sincerely,
A handwritten signature in cursive script, appearing to read "Jon Nickel".
Jon Nickel


Attachment

Cc: Chuck Figur

CERTIFICATION
PURSUANT TO U.S. v ASARCO INCORPORATED
(CV-98-3-H-CCL, USDC, D. Montana)

I certify under penalty of law that this document, 2007 Interim Measures Work Plan Addendum, Speiss-Dross and Thaw House Areas Soil Sampling, Excavation, Confirmatory Sampling, and Interim Capping Work Plan, was prepared under my direct supervision in accordance with a system designed to assure that qualified personnel gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.

Signature



Name: Thomas L. Aldrich

Title: Vice President Environmental Affairs

Date: September 25, 2007

**ASARCO EAST HELENA SMELTER
2007 INTERIM MEASURES WORK PLAN ADDENDUM**

**SPEISS-DROSS AND THAWHOUSE AREAS
SOIL SAMPLING, EXCAVATION, CONFIRMATORY SAMPLING,
AND INTERIM CAPPING WORK PLAN**

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Office of Enforcement
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Justice

Prepared by:

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September 25, 2007

TABLE OF CONTENTS

LIST OF TABLES	iii
LIST OF FIGURES	iii
LIST OF APPENDICES	iv
1.0 INTRODUCTION	1-1
1.1 MONTANA CONSENT DECREE CLEANING AND DEMOLITION PROGRAM.....	1-2
1.1.1 Work Completed in 2006.....	1-2
1.2 MONTANA ADMINISTRATIVE ORDER ON CONSENT	1-3
1.2.1 Proposed 2007 Cleaning and Demolition Work	1-3
1.2.2 Building Identification, Usage, Past Material Releases, and Existence of Subsurface Structures.....	1-4
1.3 2007 SPEISS-DROSS AND THAWHOUSE AREAS SOIL SAMPLING, EXCAVATION, CONFIRMATORY SAMPLING, AND INTERIM CAPPING WORK PLAN - SCOPE AND OBJECTIVES	1-5
2.0 2007 SPEISS-DROSS AND THAWHOUSE AREA SOIL SAMPLING, EXCAVATION AND CONFIRMATORY SAMPLING	2-1
2.1 EXISTING SOIL DATA NEAR THE FORMER SPEISS-DROSS AND THAW HOUSE AREAS	2-1
2.1.1 Post Cleaning Exposed Soil Identification and Cataloging	2-2
2.1.1.1 Exposed Soil Area Sampling	2-2
2.1.1.2 Exposed Soil Removal Criteria and Confirmatory Sampling	2-3
2.1.2 Capping of Demolished Areas	2-5
2.1.2.1 Interim Cap Techniques, Procedures, and Materials	2-6
2.1.2.2 Maintenance of Interim Cap Site Inspection	2-7
2.1.2.3 Site Security	2-8
2.1.2.4 Site Maintenance.....	2-8
3.0 SCHEDULE.....	3-1
4.0 REFERENCES	4-1

LIST OF TABLES

- TABLE 2-1. SUMMARY OF SOIL SAMPLE DATA ADJACENT TO THE FORMER SPEISS-DROSS AREA AND ADJACENT TO THE THAWHOUSE
(h:\files\007 ASARCO\1054\T07 SoilSum090407B-Rev 09-24-07.xls\Table 2-1)
- TABLE 2-2. SUMMARY STATISTICS FOR SURFACE SOILS (h:\files\007 ASARCO\1054\T07 SoilSum090407B-Rev 09-24-07.xls \Table 2-2)
- TABLE 2-3. SUMMARY STATISTICS FOR SURFACE SOILS IN THE UNPAVED ON-PLANT SITE AREA (h:\files\007 ASARCO\1054\T07 SoilSum090407B-Rev 09-24-07.xls \Table 2-3)
- TABLE 2-4. SOIL SAMPLE COLLECTION AND ANALYTICAL MATRIX
(h:\files\007 ASARCO\1054\T07 SoilSum090407B-Rev 09-24-07.xls \Table 2-4)
- TABLE 2-5. PRIORITY OF MAINTENANCE TASKS
- TABLE 2-6. EMERGENCY NOTIFICATION CONTACTS AND PHONE NUMBERS

LIST OF FIGURES

- FIGURE 1-1. RCRA CONSENT DECREE GROUNDWATER CORRECTIVE ACTION AREAS, AND MONTANA CONSENT DECREE CLEANING AND DEMOLITION AREAS (h:\files\007 ASARCO\1054\F07 RCRA CD Figures-Rev 09-24-07.ppt)
- FIGURE 1-2. SPEISS-DROSS AREA SLURRY WALL CLEANING AND DEMOLITION AREAS (h:\files\007 ASARCO\1054\F07 RCRA CD Figures-Rev 09-24-07.ppt)
- FIGURE 1-3. THAW HOUSE AREA CLEANING AND DEMOLITION AREA
(h:\files\007 ASARCO\1054\F07 RCRA CD Figures-Rev 09-24-07.ppt)
- FIGURE 2-1. ARSENIC CONCENTRATIONS IN SURFACE AND SUBSURFACE SOILS (h:\files\007 ASARCO\1054\F07 RCRA CD Figure 2-1.ppt)
- FIGURE 2-2. TEMPORARY CAP PLAN FOR COMPREHENSIVE CLEANING AND DEMOLITION (h:\files\007 ASARCO\1054\F07 RCRA CD Figures-Rev 09-24-07.ppt)
- FIGURE 2-3. SPEISS-DROSS AREA DEMOLITION FOOTPRINT EXPOSED SOIL SAMPLE SITES (h:\files\007 ASARCO\1054\F07 RCRA CD Figures-Rev 09-24-07.ppt)

- FIGURE 2-4. THAW HOUSE AREA DEMOLITION FOOTPRINT EXPOSED SOIL
SAMPLE SITES (h:\files\007 ASARCO\1054\F07 RCRA CD Figures-Rev 09-24-
07.ppt)
- FIGURE 2-5. TEMPORARY CAP DETAILS (h:\files\007 ASARCO\1054\F07 RCRA CD-
Rev 09-24-07.ppt)
- FIGURE 3-1. 2007 SOIL SAMPLING, EXCAVATION, CONFIRMATORY
SAMPLING AND INTERIM CAPPING WORK PLAN SCHEDULE
(h:\files\007 ASARCO\1054\F07 RCRA CD Figure 3-1-Rev 09-24-07.ppt)

APPENDICES

- APPENDIX A SURFACE AND SUBSURFACE SOIL SAMPLE DATA FOR
LOCATIONS NEAR OR ADJACENT TO THE SPEISS-DROSS AND
THAWHOUSE AREAS
- APPENDIX B STANDARD OPERATING PROCEDURES (SOP) FOR SURFACE
SOIL AND SUB-SURFACE SOIL SAMPLE COLLECTION
- APPENDIX C FUMED SLAG ANALYTICAL DATA
- APPENDIX D TEMPORARY CAP SPECIFICATIONS AND DETAILS
- APPENDIX E EXAMPLE INSPECTION FORM

**ASARCO EAST HELENA SMELTER
2007 INTERIM MEASURES WORK PLAN ADDENDUM**

**SPEISS-DROSS AND THAWHOUSE AREAS
SOIL SAMPLING, EXCAVATION, CONFIRMATORY SAMPLING,
AND INTERIM CAPPING WORK PLAN**

1.0 INTRODUCTION

On May 5, 1998, ASARCO LLC (Asarco) and the United States Environmental Protection Agency (EPA) entered into a Consent Decree (RCRA Consent Decree, U.S. District Court, 1998) to initiate the corrective action process in accordance with the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA). As part of the RCRA Consent Decree, Asarco prepared several site investigation documents including:

- RCRA Current Conditions/Release Assessment (CC/RA) (Hydrometrics 1999a);
- Interim Measures Work Plan, East Helena Facility (Hydrometrics, 1999b);
- RCRA Facility Investigation (RFI) Work Plan (Hydrometrics, 2000); and
- Phase I RCRA Facility Investigation Report (Asarco Consulting Inc. (ACI) 2003, revised 2005).

A complete listing of RCRA Consent Decree documents is contained in the Phase I RCRA Facility Investigation (RFI) report.

As part of the RCRA Consent Decree, several interim measures were implemented for groundwater between 1999 and 2001. These earlier interim measures (IM) performed as part of the RCRA Consent Decree are discussed in Section 1.3 of the Phase I RFI report.

In May 2002, a RCRA Interim Measures Work Plan Addendum (IMWPA) was prepared (Hydrometrics, 2002). The 2002 IMWPA addressed groundwater impact concerns in the intermediate aquifer within the City of East Helena and down-gradient residential groundwater supplies north of the Asarco Plant site. These interim measures are discussed in Section 1.2.1.3 of the IMWPA.

1.1 MONTANA CONSENT DECREE CLEANING AND DEMOLITION PROGRAM

On February 15, 2005, Asarco and MDEQ entered into a Montana Consent Decree to resolve alleged violations of the Montana Hazardous Waste Act and Montana Administrative Code. Section IV of the Montana Consent Decree requires Asarco to develop and implement a yearly Work Plan designed to remove, store, and properly dispose or recycle all remaining hazardous waste and recyclable materials from identified process units located within the East Helena Plant.

1.1.1 Work Completed in 2006

Under the Montana Consent Decree, Asarco prioritized the cleaning and demolition of the process units located in the sinter plant during calendar year 2006. The scope of this cleaning and demolition project was referred to as Phase I. In February and March 2006, Asarco submitted a draft and revised 2006 Work Plan for this project. The Department approved the Work Plan on March 17, 2006.

On July 14, 2006, Asarco submitted a revised 2006 Work Plan. This Work Plan expanded the cleaning and demolition of the process units within the East Helena Plant to include Phase I, II and III sites. The submittal described the cleaning and demolition of the following areas.

- PHASE I - Sinter plant conveyor gallery, sinter building, sinter crushing circuit, sinter returns tower, agglomerator building, coke hopper, sinter hopper, and ventilation ducting.

- PHASE II - Laboratory, dross building, bullion casting, speiss granulating pit, speiss loadout, blast furnace flue (from the dross building to the No. 1 blast furnace), and north end of blast furnace building. (The sequence and timing of the cleaning and demolition of this facility was advanced to the 2006 program to help facility the anticipated construction of a spies/dross area slurry wall in 2007.)
- PHASE III - Sinter plant baghouse, hot Cottrell, acid plant scrubbers, and mist precipitator building.

The cleaning and demolition activities outlined in the 2006 Work Plan were completed before December 31, 2006.

1.2 MONTANA ADMINISTRATIVE ORDER ON CONSENT

1.2.1 Proposed 2007 Cleaning and Demolition Work

The proposed Phase IV 2007 cleaning and demolition work was detailed in a "Bid Solicitation and Construction Documents for 2007 Cleaning & Demolition Project and CAMU – Phase 2 Cell Project" (Hydrometrics, January 2007). In response to bid submittals for the Phase IV project, Asarco selected URS/Cleveland Wrecking Company (URS/CWC) as the contractor for the 2007 Phase IV cleaning and demolition work at the East Helena facility. On May 18, 2007, Asarco submitted to MDEQ the 2007 Cleaning and Demolition Project (Work Plan). On June 13, 2007, MDEQ tentatively approved the Work Plan. Asarco has anticipated beginning construction of the Corrective Action Management Unit (CAMU) Phase 2 Cell in the spring of 2007. However, approval of the CAMU Phase 2 Cell was not obtained from EPA early enough to complete the entirety of the scheduled cleaning and demolition work as presented in the URS/CWC Work Plan. In an August 13, 2007 letter to MDEQ, Asarco described the cleaning and demolition work that will be perform in 2007. The areas scheduled for cleaning and demolition are shown on Figures 1-1, 1-2 and 1-3. As described in Figure 1-2, structures the require

demolition to accommodate equipment access for construction of the slurry wall are shown as follows:

Phase IV, Stage 1

- Contractor's Lunchroom
- Highline Railroad
- Garage
- Speiss/Dross Plant Baghouse & 200' Stack
- Blast Furnace Bldg. Remainder
- Contractor's Change Room
- Main Office
- Main Natural Gas Valve House
- Charge Building
- Thawhouse

1.2.2 Building Identification, Usage, Past Material Releases, and Existence of Subsurface Structures

The foundations beneath the garage, main natural gas valve house, speiss/dross plant baghouse and 200-foot stack, charge building, and blast furnace building remainder are comprised entirely of concrete and/or asphalt. The majority of bins under the highline railroad are comprised of concrete. The exceptions are the bins located in the northernmost section of the highline railroad, which contain exposed soils. The building footprints of the contractor's lunchroom, contractor's lunchroom, thaw house, and main office are comprised entirely of exposed soils. The areas of exposed soils are shown on Figures 1-2 and 1-3.

The contractor's lunchroom, contractor's change house, garage, main natural gas valve house, and main office are located outside of the smelting operations. The soils beneath the contractor's change house, contractor's lunchroom, and main office were isolated from process materials by their structural features. Historic releases of process material are not apparent in any of the exposed soils (beneath or outside the building's footprint) in these areas. The highline railroad southernmost concrete bins served as storage areas for process materials, including speiss and dross. The highline railroad exposed soil bins were not used for any material storage purpose. The upper surface of exposed soils within the thaw house interior footprint shows evidence of historical ore and concentrate spillage.

Subsurface structures (natural gas lines, water lines, utility lines) are present in the footprints of the 2007 cleaning and demolition project. The abandoned natural gas lines and sanitary sewer lines in the vicinity of the contractor's lunchroom, contractor's change house, highline railroad garage, main office, main natural gas valve house will be flow filled as part of the speiss/dross area slurry wall construction. The abandoned city water lines feeding the contractor's lunchroom, contractor's change house, and main office have been drained and will be abandoned in place. The abandoned natural gas line feeding the thaw house will be capped at the northeast corner of the thaw house. The underground de-energized electrical conduit feeding the thaw house will be capped near the concentrate storage and handling building. Electrical power to other buildings located within the 2007 cleaning and demolition project was supplied through overhead transmission lines. Two non-pressurized plant water drainage line are located beneath the highline railroad underpass and near the charge building, which bisect the speiss/dross area slurry wall construction zone. These two drain lines, along with connecting plant drain lines on the east perimeter of the slurry wall footprint will be abandoned and sealed with flow fill as part of the speiss/dross plant area slurry wall construction project.

1.3 2007 SPEISS-DROSS AND THAWHOUSE AREAS SOIL SAMPLING, EXCAVATION, CONFIRMATORY SAMPLING, AND INTERIM CAPPING WORK PLAN - SCOPE AND OBJECTIVES

The cleaning and demolition work plan that addresses the 2007 actions has been prepared and tentatively approved by MDEQ. EPA has requested the submittal of a specific work plan for the soil sampling, excavation, confirmation sampling, and interim capping for exposed soil areas within the areas scheduled for cleaning and demolished in 2007.

The objectives of this 2007 IM Work Plan Addendum for soil sampling, soil excavation, confirmatory sampling, and interim capping are:

- Discuss existing soil data obtained from sample sites adjacent to structures in the Speiss Dross and the Thawhouse areas.
- Identification and catalog of exposed areas within demolition footprint.
- Outline the soil sampling, excavation, and confirmatory sample protocols and procedures for assessment of exposed portions within the demolished areas.
- Outline the areas in which backfilling using fumed slag will be required to achieve proper site stabilization and drainage.
- Present the locations that will require interim capping.
- Provide the interim capping techniques, procedures, and materials that will be used to inhibit infiltration of precipitation within the demolition areas.
- Outline the general, short-term operation and maintenance for the interim cap.

2.0 2007 SPEISS-DROSS AND THAWHOUSE AREA SOIL SAMPLING, EXCAVATION AND CONFIRMATORY SAMPLING

2.1 EXISTING SOIL DATA NEAR THE FORMER SPEISS-DROSS AND THAW HOUSE AREAS

Figure 2-1 shows arsenic profile data across the plant site. Using arsenic concentrations as an indicator, arsenic and metals are generally elevated in surface and near surface soils through out the plant area. Arsenic and metals generally decrease with depth.

Arsenic and metals data from surface and subsurface soil samples collected from monitoring wells and surface soil sample sites adjacent to or near the former speiss-dross area and near the thaw house are in Appendix A and are summarized on Table 2-1. Sample site locations are shown on Figure 2-1. Unpaved soils site (UPS-SS13) and monitoring well soil sample results (DH-13, DH-26, DH-27, and DH-30, DH-35 and DH-36) show elevated metals in near surface soils (0 to 6 feet) but generally decrease with depth below the five or six-foot interval. In the area, unpaved soil sample sites (UPS-SS06, UPS-SS08, LOS-SS14, LOS-SS116A and LOS-116B) and monitoring well DH-66 show soils in the thaw house area are also elevated metals in near surface soils but concentrations decrease significantly below the 4 foot depth interval.

Table 2-2 presents site wide surface soil statistics for the plant site. The source of this data is the 2003 Phase I RFI (ACI, 2003). In general, soils are sometimes above the site wide average for the site but less than maximum recorded values for the site.

Table 2-2 presents summary statistics for all surface soils sampled at the plant site (unpaved plant site soils, upper ore storage area, lower ore storage area, and rail road corridors), and Table 2-3 presents summary statistics for unpaved on-plant site soils areas. Comparison of the summary statistics with Table 2-1 shows that soil adjacent to the speiss/dross area and the thaw house in general are lower than mean surface soil concentrations for all soil sample areas and for unpaved areas on the plant site. The one exception was surface soils for DH-13, which is about 200 feet from the speiss-dross area

(see Figure 2-1), which had the highest measured concentrations for arsenic, cadmium and lead, compared to other unpaved area sample sites.

2.1.1 Post Cleaning Exposed Soil Identification and Cataloging

Once cleaning and demolition is complete and the debris has been removed from the 2007 cleaning and demolition work plan areas, a final inspection of the demolished structure floor footprint of the area will be conducted. A visual survey will be conducted to catalog any area within the structure footprints where asphalt or concrete is not present and underlying soils may have been exposed to dust or other high metal concentration materials. The survey will also document the condition of asphalt or concrete within the structures and floors. The documentation will include a description and photographs. All exposed soil areas, broken or severely cracked asphalt or concrete areas will be mapped and recorded on plan views of the demolished structures.

2.1.1.1 Exposed Soil Area Sampling

Initial Soil Sample Collection

If exposed soil areas are encountered within the cleaning and demolition footprints, the exposed soil area will be sampled and analyzed for indicator parameters and supplemental parameters using wet chemistry standard EPA methods. The soil sample collection and analytical matrix is summarized in Table 2-4. Exposed soil areas will be analyzed for soil indicator parameters of arsenic, copper, cadmium, lead, zinc and selenium, as well as for supplemental parameters that include aluminum, antimony, barium, beryllium, chrome, cobalt, iron, manganese, mercury, nickel, silver thallium and vanadium.

A total of five surface (0-4 inch increment) soil samples will be collected from each sample site in identified exposed soil areas and composited into one representative sample of the area. Surface soil samples will be collected using hand tools (hand shovel, trowels, or hand augers). The samples will be stored in ziplock baggies and archived for analysis. All analytical work will be conducted before the 6-month holding time limit for metals. The location of each soil sampling site will be cataloged using sample numbers

and GPS coordinates. Sites with visually obvious dust or that exceed the numerical criteria described above and in Table 2-4 will be considered candidates for subsurface soil excavation. The sampling Standard Operation Procedures (SOPs) and analytical parameters and methods are summarized in Table 2-4. For convenience, the relevant SOPs from the IM and RFI work plans are in Appendix B of this Work Plan.

Surface soil samples will be collected from exposed soil areas using the same techniques and procedures used for Interim Measures (IM) and RCRA Facility Investigation (RFI) activities, as described in the IM and RFI Work Plans (Hydrometrics 1999b and Hydrometrics 2000). Surface soil sample sites are shown in Figures 2-3 and 2-4.

2.1.1.2 Exposed Soil Removal Criteria and Confirmatory Sampling

Since dust metal concentrations in former processing areas such as the former speiss-dross handling area or the thaw house may range in the percent range (10,000 mg/l to 200,000 mg/l), initial soil sample results in this concentration range will be indicative of remaining processing dust or materials residuals, or impacted soils. Where unpaved soil areas within demolition structure footprints have been exposed to dust or other high metal concentration materials, limited excavation of dust material residuals and impacted soils will be conducted. As excavation occurs, soil samples will be collected at the intervals shown in Table 2-4 and analyzed for indicator parameters (arsenic, cadmium, copper, lead, zinc and selenium). Samples collected during excavation will be either field tested using a portable X-Ray Fluorescence (XRF) analyzer, or alternatively analyzed using standard EPA methods. The advantage of use of a field XRF is rapid turnaround time and the ability to make decision on excavation limits as the work is being conducted. Conversely, laboratory analysis may result in delay getting results and affect the duration of the excavation effort and its associated costs. The soil sample collection and analytical matrix is summarized in Table 2-4.

The criteria for excavation is as follows:

- Excavation of obvious dust or impacted soil based on visual observation. Ore processing dust is generally very fine grained and gray to black in color. This generally contrasts with native soils which can be fine to coarse grained, typically show traces of sand and gravel, and are generally a tan or brown color where they have not been impacted.
- Exposed soils or materials within demolished structures footprint in the former speiss-dross area or the thaw house that exceed the unpaved on-plant site area soils arithmetic mean for the 2-4 foot interval as shown on Table 2-3 and on summarized in Table 2-4 will be excavated. Since soil concentrations are elevated throughout unpaved areas on the plant site, the arithmetic mean for unpaved plant site soils in the 2-4 foot interval has been arbitrarily selected as a relatively conservative target for soil removal. Soils will be excavated until:
 - The values for arsenic, copper, cadmium, lead and zinc are below the arithmetic mean as shown in Table 2-3 and as summarized in Table 2-4, or
 - The practical excavation limit of excavation equipment is reached (depending on access, this is typically 12 to 15 feet), or
 - The water table is encountered.
- Following excavation, samples collected from the deepest interval sampled will be analyzed for indicator parameters and supplemental parameters using wet chemistry standard EPA methods. The final sample increment will be retained and analyzed for SPLP.

The above exposed soil area cleanup criteria are summarized on Table 2-4.

Sub-surface samples will be collected directly from the soil excavation equipment bucket in the following increments until excavation depth criteria described above and summarized in Table 2-4 are met. Sub-surface soil increments are: 4-12", 1-2', 2-4', 4-6', 6-8', 8-10', 10-12', and 12-15', as necessary. One soil sample will be collected directly from the backhoe bucket for each increment within an identified exposed soil

sample area. Excavation and sampling will continue using the procedure described above until numeric criteria are met, or practical excavation limits prohibit further excavation.

Sub-surface soil samples will be collected from exposed soil areas using the same techniques and procedures used for Interim Measures (IM) and RCRA Facility Investigation (RFI) activities, as described in the IM and RFI Work Plans (Hydrometrics 1999b and Hydrometrics 2000). Samples will be stored in ziplock baggies and archived until the project is complete, or if the sample is used for wet chemistry analysis. If any future analytical work will be conducted, it will be completed before the 6-month holding time limit for metals.

2.1.2 Capping of Demolished Areas

The areas where above grade demolition activities have been completed will be sealed in a manner that will mitigate the infiltration of water below the footprint area through existing or created cracks and crevices. Demolition footprint areas will be covered as delineated on Figure 2-2 with 10-oz geotextile and a geomembrane cap of 24-mil RPE liner.

Upon completion of the cleaning and demolition operations, URS/CWC will remove all debris and items from the slab that could possibly penetrate the subject geotextile and geomembrane. URS/CWC will utilize the existing on-site fumed slag as fill material over the remaining demolition slabs/areas. This fumed slag will be placed and rough graded to create the positive drainage required per the Construction Document Drawings. The fumed slag has been used as a grading material at the plant site in the past and possesses good physical characteristics for fill or sub-foundation uses (granular material and compacts wells). Although fumed slag contains elevated total metal concentrations, the metals are bound in a silicate-iron matrix with characteristics of low metal leachability. The potential for metal migration from the fumed slag is low. In response to EPA's July 6, 2006 comments, Asarco provided the rationale for using fumed slag for backfilling purposes, including study results derived from the RCRA Consent Decree investigations. The slag-related investigative results contained in the Current Condition

Release Assessment (CC/RA, January 1999) and qualitative analyses of fumed slag (May 2001) are attached as Appendix C. In April 2005, Montana Department of Environmental Quality representatives collected fumed slag samples from the East Helena Plant to assess the potential environmental impacts from its use as an iron substitute within the cement manufacturing industry. A copy of the April 2005 fumed slag sampling event results is attached as Appendix C. A July 2006 Department Environmental Impact Statement (EIS) may contain additional slag related information.

The geotextile and geomembrane will be laid, seamed, and secured as detailed. Additionally, sandbags will be placed intermittently within the center liner area to prevent the liner from being picked up by wind uplift or other forces. This will be done in sufficient quantity to ensure the liner stays in place. As an added preventative measure, URS/CWC will utilize sandbags made of UV Resistant 9-mil PE, which will provide superior UV resistance (compared to standard plastic woven sandbags) to prevent breakdown by sunlight.

URS/CWC will utilize the services of a subcontractor, Northwest Lining & Geotextile Products, Inc., for the installation of the temporary demolition caps. Complete details for the geotextile, geomembrane, and liner attachment to be utilized are in Attachment C of the 2007 Cleaning and Demolition Work Plan (URS, 2007) and are also in Appendix D of this Work Plan.

2.1.2.1 Interim Cap Techniques, Procedures, and Materials

The interim caps will be constructed to cover newly exposed footprints in the demolition areas. Depending on when the work is initiated, work sequencing and/or weather conditions, the interim cap installation may be conducted before final removal of material and impacted subsurface soils in exposed areas (see 2.1.1.1 above). Scheduling is discussed further in Section 3.0.

The interim cap details and specifications are shown on Figure 2-5. In general, from the top down, the interim cap will consist of the following:

- Sand bags to hold down the interim cover during windy periods;
- A 24-mil reinforced polyethylene (RPE) with the PRE seams overlapped 3 inches and sealed with a butyl rubber seaming tape;
- A minimum 10 ounce non-woven geotextile;
- A prepared sub-grade consisting of fumed slag fill for grading purposes; and
- Existing soils, concrete/asphalt slabs and/or concrete foundations.

2.1.2.2 Maintenance of Interim Cap Site Inspection

Periodic inspections of the interim cap will be conducted to ensure that the interim cap systems are performing adequately and to identify problems and provide proper maintenance of interim cap systems. The inspection program will involve three types of inspections: (1) informal inspections, (2) periodic technical inspections, and (3) special inspections after extreme events.

The informal inspection is actually a continuing effort by on-site personnel, performed in the course of their normal duties. Periodic technical inspections and inspections after extreme events will be performed by onsite Asarco staff (or other technical representatives) familiar with the design and construction of the cover systems. The periodic technical inspection will be performed monthly to document the condition of the cap components. Special inspections are very similar to periodic technical inspections but are performed only after an extreme event such as a rare rainstorm, tornado, or earthquake.

The inspection of the cover systems will typically involve walking the entire site in a systematic fashion that ensures a comprehensive review. If any problem or deficiency is found, the inspector should record the location on a field sketch. A complete description of the affected area, including all pertinent data (i.e., size of the area and other descriptive remarks such as exposed synthetic materials) should be recorded on the appropriate reporting forms. An accurate and detailed description of observed conditions will enable a meaningful comparison of conditions observed at different times.

Photographs may be helpful in documenting problems. Provisions should be made to keep a photographic log of problems, repairs, and general site conditions. This log will provide valuable information when evaluating the performance of the cover system and when planning repair strategies.

It is important to have a record of site conditions at various stages after capping. Good documentation will provide valuable information to help maintenance and repair planning. Inspection checklists to assist in the inspection and documentation procedures should be developed and modified as needed throughout the interim capping period. The checklist will (at a minimum) contain items to evaluate such as membrane condition, sand bag condition, liner seams, liner/concrete attachments and site drainage. A copy of an example inspection form is attached in Appendix E.

2.1.2.3 Site Security

The interim cap will be contained within the fenced Asarco facility and will be kept secured so that people or animals do not disturb the cap. Site access by ongoing plant or demolition operations will be limited through the use of barricades, barrier tape, or temporary fencing. Plant personnel will advise contractors conducting site activities of access limits within or near capped areas.

2.1.2.4 Site Maintenance

As shown in Table 2-5, there are four different types of maintenance tasks listed by priority rather than by frequency. Table 2-5 is provided as a guide to prioritize the different types of maintenance activities in proper perspective. The different types of maintenance are also discussed in the following subsections.

1. Emergency maintenance - Emergencies are situations arising unexpectedly that require urgent attention. Often, immediate response must be provided to avert potential serious damage. Provisions for emergency repair/damage control activities must therefore be in-place prior to the occurrence. Toward this end, an Emergency Contacts list will be prepared and kept current, and include local emergency

response organizations, assigned maintenance personnel, and agency and owner representatives. Table 2-6 provides a partial list of emergency contacts.

2. Preventative maintenance - Preventative maintenance will be performed to extend the life of equipment and structures. With the exception of routine surveillance and inspections, preventative maintenance tasks should be scheduled in accordance with the recommendations of the material and equipment manufacturers. Scheduled inspection and maintenance of all site facilities will help ensure that potential problems are discovered and corrected before they become serious, as well as providing for the performance of periodically required upkeep. During routine inspections, the Asarco personnel should be alert for any abnormal conditions, which could indicate potential problems.
3. Corrective maintenance - Corrective maintenance consists of repair and other non-routine maintenance. Asarco personnel must always be ready to handle these tasks as the need arises. Corrective maintenance procedures should follow the equipment or material manufacturer's recommendations. In planning for the corrective maintenance, arrange for the assistance of an engineer or manufacturer's representative, if necessary.
4. Housekeeping - Maintaining well-kept facilities indicates pride on the part of the Asarco personnel, and provides for good and efficient operations. Well-kept property cultivates good neighbor relations with adjacent property owners. Housekeeping tasks may include collecting/disposing of litter or debris and maintaining access barriers.

3.0 SCHEDULE

A preliminary schedule for the 2007 cleaning and demolition, and soil sampling project is in Figure 3-1. The schedule is preliminary and is dependent on the sequencing of several other cleaning and demolition projects that are addressed in the Cleaning and Demolition Plan (URS, 2007). Key events include:

- Demolition of structures in the former speiss-dross area.
- Sample collection in exposed areas within the footprint of structures demolished in the speiss-dross area and the thaw house area.
- Initial site preparation including interruption of utilities that are in the construction pathway for the speiss-dross slurry wall.
- Construction of the slurry wall.
- Excavation and any necessary sampling in exposed soil areas that are within the footprint of demolished structures.
- Interim Cap.

Depending on when the work is initiated, work sequencing and/or weather conditions, the interim cap installation may be conducted before final removal of material and impacted subsurface soils in exposed areas. In this case, the final cleanup of material and associated impacted soils within the footprint would be conducted in the 2008 season.

4.0 REFERENCES

- Asarco Consulting, Inc., 2003. Phase I RCRA Facility Investigation Report (revised 2005).
- Hydrometrics, 2007. Bid Solicitation and Construction Documents for 2007 Cleaning & Demolition Project and CAMU – Phase 2 Cell Project, Asarco East Helena Plant, East Helena Montana, January 2007.
- Hydrometrics, 2002. RCRA Interim Measures Work Plan Addendum (IMWPA). 2002.
- Hydrometrics, 2000. RCRA Facility Investigation Work Plan, East Helena Facility, March 2000.
- Hydrometrics, 1999a. RCRA Current Conditions/Release Assessment (CC/RA). 1999.
- Hydrometrics, 1999b. Interim Measures Work Plan, East Helena Facility, April 1999, Revised July 1999. Includes Volume II, Corrective Action Management Unit Design Report.
- URS, 2007. Work Plan, 2007 Cleaning & Demolition Project and CAMU Phase 2 Cell Project, Asarco East Helena Plant, East Helena, Montana, (Draft for Internal Review), April 2007.

TABLE 2-1. SUMMARY OF SOIL SAMPLE DATA ADJACENT TO THE FORMER SPEISS-DROSS AREA AND ADJACENT TO THE THAWHOUSE

0"-4" Depth Interval		Surface Soil Sample Site Number							Monitoring Well Soil Sample Site Number				
Parameter	UPS-SS-13	UPS-SS06	UPS-SS08	LOS-SS14	LOS-116A	LOS-SS16B	DH-13	DH-26	DH-27	DH-30	DH-35	DH-36	DH-66S
ARSENIC (AS) TOT	1748	45	203	1007	276	261	3163				2346		
COPPER (CU) TOT	8221	179	787	1522	797	812	17125				8679		
CADMIUM (CD) TOT	843	92	80	277	208	216	1610				538		
LEAD (PB) TOT	14989	630	2624	7975	3331	3361	24200				12879		
ZINC (ZN) TOT	8045	350	1347	4387	2668	3002	14450				8672		
4"-12" Depth Interval													
ARSENIC (AS) TOT	1924	1879	83	1353	21		389						
COPPER (CU) TOT	7438	3892	259	1888	40		930						
CADMIUM (CD) TOT	501	701	48	441	<10		84						
LEAD (PB) TOT	14334	24682	1169	15362	114		11290						
ZINC (ZN) TOT	9131	18867	828	6263	96		588						
0'-2' Depth Interval													
ARSENIC (AS) TOT	1924	1879	83	1353	21		389						1052
COPPER (CU) TOT	7438	3892	259	1888	40		930						2472
CADMIUM (CD) TOT	501	701	48	441	<10		84						392
LEAD (PB) TOT	14334	24682	1169	15362	114		11290						19608
ZINC (ZN) TOT	9131	18867	828	6263	96		588						10780
1'-2' Depth Interval													
ARSENIC (AS) TOT	1894	48	80	1100	17		28			1288		447	
COPPER (CU) TOT	7092	154	148	1213	47		88			4970		873	
CADMIUM (CD) TOT	312	28	33	661	<10		2			234		34	
LEAD (PB) TOT	19676	694	913	12027	127		209			11574		4300	
ZINC (ZN) TOT	13821	605	612	10971	123		66			26012		28454	
2'-4' Depth Interval													
ARSENIC (AS) TOT	415	27	48	210	15	18	65	450	32	6523	1491	23	
COPPER (CU) TOT	1695	133	147	425	38	23	75	350	63	110	6166	54	
CADMIUM (CD) TOT	50	17	28	40	<10	<10	3	60	1	2855	445	<10	
LEAD (PB) TOT	9636	945	722	1760	45	47	273	25500	9	19079	8529	80	
ZINC (ZN) TOT	41455	532	493	1715	74	88	111	520	140	1045	7505	450	
3'-4' Depth Interval													
ARSENIC (AS) TOT		14			12		32						127
COPPER (CU) TOT		43			23		25						535
CADMIUM (CD) TOT		<10			<10		1						97
LEAD (PB) TOT		110			26		63						2569
ZINC (ZN) TOT		103			55		52						1390
4'-6' Depth Interval													
ARSENIC (AS) TOT					15	22	27	275	132	6739	91	27	
COPPER (CU) TOT					22	35	31	14	76	111	207	83	
CADMIUM (CD) TOT					<10	<10	1	2	2	3011	<10	<10	
LEAD (PB) TOT					17	29	86	23	22750	19549	444	43	
ZINC (ZN) TOT					57	69	42	38	105	1082	648	192	
6'-8' Depth Interval													
15-17"													
ARSENIC (AS) TOT					11			164	162		222	21	178
COPPER (CU) TOT					18			28	35		138	76	508
CADMIUM (CD) TOT					<10			3	2		<10	<10	103
LEAD (PB) TOT					17			105	7		182	23	3086
ZINC (ZN) TOT					42			100	38		113	70	1911
8-10' Depth Interval													
ARSENIC (AS) TOT								172	74	754	83		
COPPER (CU) TOT								30	77	190	84		
CADMIUM (CD) TOT								1	1	1465	<10		
LEAD (PB) TOT								21	34	127	38		
ZINC (ZN) TOT								43	72	1175	87		
10-12' Depth Interval													
ARSENIC (AS) TOT						81		100		731	72		15
COPPER (CU) TOT						24		48		89	114		45
CADMIUM (CD) TOT						<10		3		1081	<10		<10
LEAD (PB) TOT						25		91		127	56		22
ZINC (ZN) TOT						66		100		1281	109		88
15-17' Depth Interval													
ARSENIC (AS) TOT								92		160	90	<10	27
COPPER (CU) TOT								65		76	92	66	49
CADMIUM (CD) TOT								1		1686	<10	<10	<10
LEAD (PB) TOT								23		93	41	21	25
ZINC (ZN) TOT								62		774	63	116	42
20-22' Depth Interval													
ARSENIC (AS) TOT								100		502	128	88	
COPPER (CU) TOT								90		138	66	75	
CADMIUM (CD) TOT								2		610	57	<10	
LEAD (PB) TOT								42		31	42	23	
ZINC (ZN) TOT								81			83	73	
25-25.5' Depth Interval													
24-26'25-27'													
ARSENIC (AS) TOT							1434	122	100		221	161	14
COPPER (CU) TOT							200	74	32		70	62	77
CADMIUM (CD) TOT							10	5	11		567	<10	<10
LEAD (PB) TOT							120	440	14		26	18	47
ZINC (ZN) TOT							1013	425	720		77	71	53

TOT = Total
All analytical values are in mg/Kg

TOT = Total
All analytical values are in mg/Kg
Source: Appendices 2 and 7, Phase I RFI Report, ACI, 2003.□

Note: Depth intervals have been normalized for comparison purposes. For example, the 4-6 foot increment in some samples may actually be a 3-5 foot sample increment. The actual sample increments are in the data reports included in Appendix 1

Shading = No data available for these depth intervals

TABLE 2-2. SUMMARY STATISTICS FOR SURFACE SOILS

0"-4" Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	173/183	2159	1028	0.01	35500	SS-12	3753	16.5	26	432
COPPER (CU) TOT	175/183	5522	3225	0.01	35750	RC-SA02D-1, 4/24/2001	6917	16.3	69	1127
CADMIUM (CD) TOT	167/183	1225	354	0.05	23400	SS-18	2830	0.24	816	196
LEAD (PB) TOT	177/183	16615	10875	0.01	73866	RC-SS17, 4/18/01	17967	11.6	296	3439
ZINC (ZN) TOT	179/183	13672	7916	0.05	88519	RC-SS25, 4/25/01	17388	46.9	63	2940

4"-12" Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	144/155	1133	503	0.10	8753	RC-SS05C-2, 4/6/2001	1518	16.5	17	276
COPPER (CU) TOT	148/155	2624	1319	0.10	16054	RC-SS05C-2, 4/6/2001	3421	16.3	37	604
CADMIUM (CD) TOT	136/155	662	239	0.05	13992	RC-SS06, 4/06/01	1436	0.24	535	128
LEAD (PB) TOT	152/155	12717	7125	0.05	77220	RC-SS07D, 4/09/01	16583	11.6	210	2431
ZINC (ZN) TOT	153/155	9791	6263	0.05	57288	RC-SA06, 4/24/01	11284	46.9	53	2492

1'-2' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	148/154	825	338	0.03	9256	UOS-SS11-3, 10/3/2001	1405	16.5	13	209
COPPER (CU) TOT	148/154	1999	790	0.01	64908	UPS-SS01-3, 3/20/2001	5521	16.3	26	416
CADMIUM (CD) TOT	121/154	415	111	0.02	10110	RC-SS06, 4/06/01	980	0.24	303	73
LEAD (PB) TOT	152/154	8147	3219	0.03	64307	UPS-SS01, 3/20/01	11119	11.6	136	1574
ZINC (ZN) TOT	153/154	6552	4166	0.05	35772	RC-SS20, 4/18/01	7035	46.9	38	1795

2'-3' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	116/128	518	130	0.012	4455	RC-SS06-4, 4/6/2001	906	16.5	6	97
COPPER (CU) TOT	122/128	1130	396	0.004	6741	RC-SS08-4, 4/9/2001	1579	16.3	14	229
CADMIUM (CD) TOT	92/128	397	44	0.003	13588	RC-SS06, 4/06/01	1316	0.24	174	42
LEAD (PB) TOT	123/128	5153	1193	0.003	37460	LOS-SS06, 4/06/01	7888	11.6	60	696
ZINC (ZN) TOT	127/128	6070	1731	0.032	56395	LOS-SS05, 4/05/01	9052	46.9	21	979

3'-5' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	36/39	300	165	10.00	1608	UOS-SS05-5, 4/17/2001	407	16.5	7	115
COPPER (CU) TOT	39/39	671	286	21.00	5763	UOS-SS07-5, 4/17/2001	1051	16.3	15	239
CADMIUM (CD) TOT	28/39	202	51	5.00	1430	RC-SS07C, 4/9/01	349	0.24	203	49
LEAD (PB) TOT	39/39	3547	1885	27.00	15928	UOS-SS05, 4/17/01	4456	11.6	93	1078
ZINC (ZN) TOT	39/39	3159	1000	45.00	12826	LOS-SS10, 4/6/01	3904	46.9	21	980

5'-8' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	30/31	304	49	11.00	2553	RC-SA08A-5, 4/25/2001	592	16.5	4	73
COPPER (CU) TOT	31/31	715	116	17.00	6181	RC-SS27-6, 4/9/2001	1339	16.3	11	185
CADMIUM (CD) TOT	24/31	131	32	5.00	741	RC-SS27, 4/9/01	188	0.24	170	41
LEAD (PB) TOT	31/31	5463	1593	23.00	26889	RC-SS27, 4/9/01	7733	11.6	109	1267
ZINC (ZN) TOT	31/31	4987	1354	46.00	39575	RC-SA06, 4/24/01	8190	46.9	26	1219

8'-11' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	4/4	408	181	16.00	1255	RC-SA08B-8, 4/25/2001	570	16.5	10	160
COPPER (CU) TOT	4/4	779	669	44.00	1734	RC-SA08B-8, 4/25/2001	704	16.3	26	429
CADMIUM (CD) TOT	2/4	68	8	5.00	251	RC-SA08B, 4/25/01	122	0.24	68	16
LEAD (PB) TOT	4/4	1126	182	176.00	3962	RC-SA08B, 4/25/01	1891	11.6	34	390
ZINC (ZN) TOT	4/4	2531	360	138.00	9265	RC-SA08B, 4/25/01	4492	46.9	13	618

TOT = Total

1/2 the detection limit used for non-detected values.

All analytical values are in mg/Kg

Source: Table 2-3-1, Phase I RFI Report, ACI, 2003.

TABLE 2-3. SUMMARY STATISTICS FOR SURFACE SOILS IN THE UNPAVED ON-PLANT SITE AREA

0"-4" Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geomean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	19/19	2174	460	0.10	17075		3970	16.5	19	315
COPPER (CU) TOT	19/19	5119	1100	0.10	35350		8806	16.3	44	709
CADMIUM (CD) TOT	18/19	662	433	0.05	3069	UPS-SS1, 3/20/01	954	0.24	1121	269
LEAD (PB) TOT	18/19	9024	8813	0.05	39046	UPS-SS4, 3/16/01	10263	11.6	281	3256
ZINC (ZN) TOT	18/19	12039	6421	0.05	84650	SS-31	21706	46.9	71	3318

4"-12" Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	16/18	678	349	0.10	2148		723	16.5	10	160
COPPER (CU) TOT	18/18	1970	754	0.10	9395		2673	16.3	20	326
CADMIUM (CD) TOT	16/18	224	88	0.05	901	UPS-SS1, 3/20/01	267	0.24	263	63
LEAD (PB) TOT	17/18	7345	4625	0.05	24682	UPS-SS6, 3/20/01	7703	11.6	114	1322
ZINC (ZN) TOT	17/18	9619	7874	0.05	41322	UPS-SS14, 3/20/01	11105	46.9	33	1548

1'-2' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	14/15	610	164	0.10	3100		941	16.5	7	119
COPPER (CU) TOT	15/15	5385	206	0.10	64908		16574	16.3	17	274
CADMIUM (CD) TOT	11/15	92	38	0.05	312	UPS-SS13, 3/20/01	102	0.24	117	28
LEAD (PB) TOT	14/15	8304	968	0.05	64307	UPS-SS1, 3/20/01	17002	11.6	73	846
ZINC (ZN) TOT	14/15	4921	1647	0.05	22123	UPS-SS12, 3/16/01	6868	46.9	15	722

2'-4' Depth Interval

Parameter	Detection Frequency	Arithmetic Mean	Median	Minimum	Maximum	Location of Maximum	Standard Deviation	Geo. Mean Background	Enrichment Factor	Geometric Mean
ARSENIC (AS) TOT	12/13	165	130	10	465		162	16.5	5	84
COPPER (CU) TOT	13/13	778	147	14	3522		1095	16.3	13	218
CADMIUM (CD) TOT	8/13	35	17	5	107	UPS-SS1, 3/20/01	35	0.24	80	19
LEAD (PB) TOT	13/13	2080	932	23	9636	UPS-SS13, 3/20/01	2884	11.6	52	598
ZINC (ZN) TOT	13/13	7881	532	15	41455	UPS-SS13, 3/20/01	13187	46.9	18	852

TOT = Total

1/2 the detection limit used for non-detected values.

All analytical values are in mg/Kg

Source: Table 2-3-3, Phase I RFI Report, ACI, 2003.

TABLE 2-4. SOIL SAMPLE COLLECTION AND ANALYTICAL MATRIX

Sample Location	Purpose	Sample	Number of Sampling Events	Sampling Standard Operating Procedures	Analytical Parameters	Methods	Project Detection Limit Goal	Excavation Concentration Removal Limits (mg/kg or ppm)	Soil Excavation Removal and Sampling Protocols in Unpaved Bare Soil Areas Within the Demolition Foot Print Area
		Sample Depth Intervals ⁽¹⁾							
Highline Tressel Foot Print (10 Sites)	Remove and impacted soils in exposed or unpaved areas within the structure demolition foot print. Determine depth of excavation.	Sample from Excavator Bucket. Sample intervals:	1	HF-SOP-2	As	XRF	10 ppm	165	Obvious impacted soils are removed based on visual observation (fine texture, dark gray color). Excavation continues until: - The values for As, Cd, Cu, Pb, Zn are below removal limits - The practical limit of excavation equipment is reached (typically 12 to 15 feet) Source: Table 2-3, arithmetic mean for the 2 to 4 foot increment. - The water table is encountered. The final sample increment is retained and analyzed for SPLP.
Contractors Lunch Room (2 Sites)		4"-12"		HF-SOP-4	Cd	XRF	10 ppm	778	
Garage (1 Site)		0-4"		HF-SOP-5	Cu	XRF	10 ppm	35	
		1'-2'		HF-SOP-7	Pb	XRF	10 ppm	2080	
Thaw House (5 Sites)		2'-4'		HF-SOP-29	Zn	XRF	10 ppm	7881	
		4'-6'		HF-SOP-31					
Main Office (1 Site)		6'-8'		HF-SOP-58					
		8'-10'		HS-SOP-6					
		10'-12'		HS-SOP-13					
		12-15'		HS-SOP-57					
	Document metal concentrations in test leachate from the SPLP testing procedure	Final increment sampled from excavator bucket and sampled for metals and analyzed by XRF	1		As Cd Cu Pb Zn	SPLP (EPA 1312) SPLP (EPA 1312) SPLP (EPA 1312) SPLP (EPA 1312) SPLP (EPA 1312)	0.1 mg/l 0.1 mg/l 0.1 mg/l 0.1 mg/l 0.1 mg/l		

(1) Sample depths are approximate; actual depths will be based on field conditions.

NOTES: Duplicates will be collected at a minimum frequency of 1 per 20 field samples. Duplicates for SPLP analysis will be submitted at a frequency of 1 per 20 samples selected for SPLP.
Detection limits for SPLP analysis have been set at 100x below regulatory limits.
Sample site locations will be surveyed by GPS during or after samples are collected.

TABLE 2-5. PRIORITY OF MAINTENANCE TASKS

Priority	Type of Maintenance	Description and Example
1	Emergency	A situation requiring immediate attention (for example, fire or flood).
2	Preventative	Scheduled inspection and minor repairs carried out during inspection (for example, cleaning of membrane liner).
3	Corrective	Corrective maintenance required as a direct result of scheduled inspection (for example, repair of torn membrane liner).
4	Housekeeping	Routine housekeeping of buildings and grounds (for example, disposal of debris and general housekeeping).

**TABLE 2-6. EMERGENCY NOTIFICATION
CONTACTS AND PHONE NUMBERS**

General Emergency Numbers:

Fire Department	911
Ambulance	911
Police	911

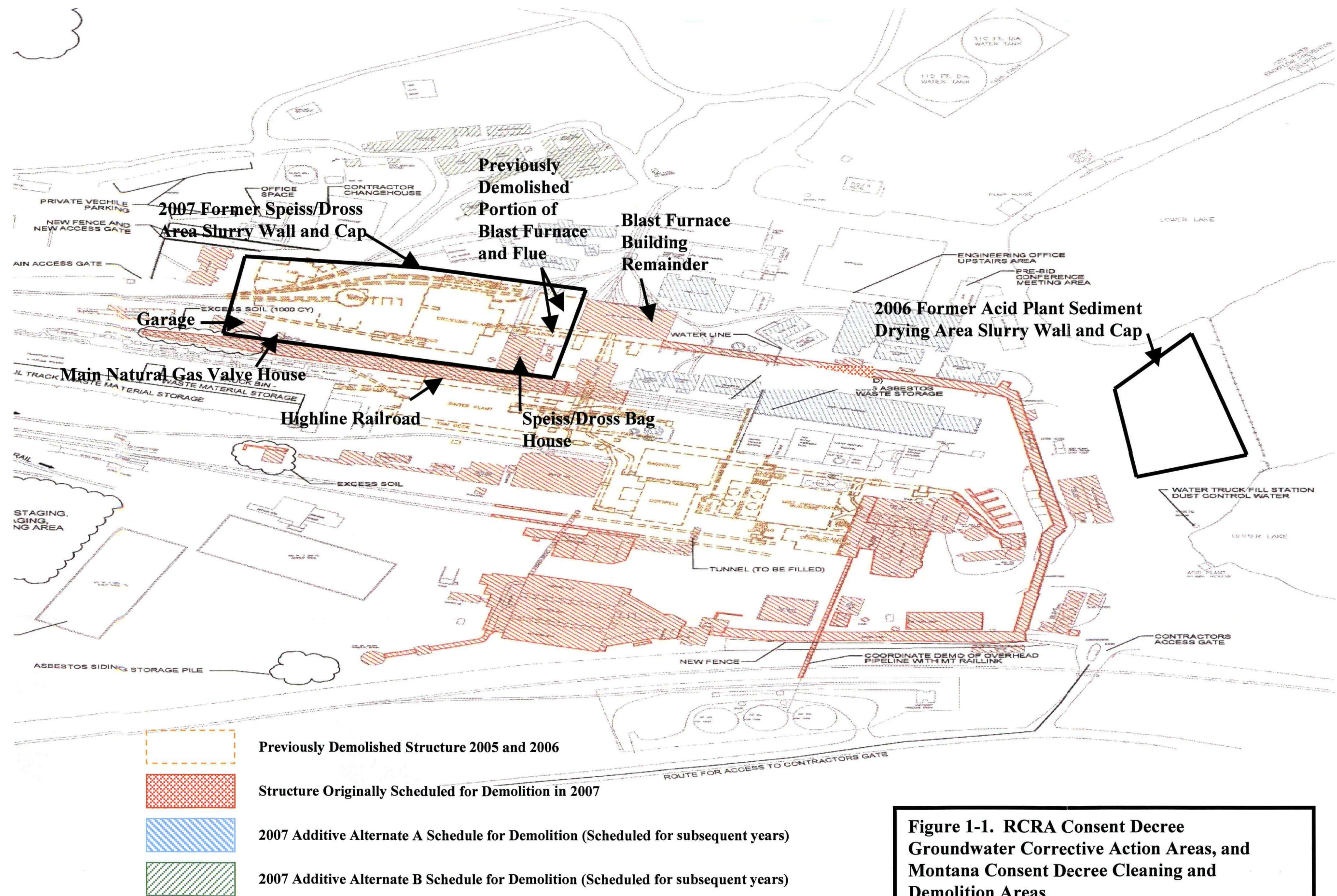
Corporate Resources

ASARCO LLC

Blaine Cox	(East Helena Smelter)	(406) 227-4098
	Cell	(406) 459-8542
Jon Nickel	(East Helena Smelter)	(406) 227-4529

OTHER RESOURCES:

U.S. EPA (24-hour emergency)	(206) 553-1263
Superfund/RCRA Hotline	(800) 424-9346
Hydrometrics, Inc	(406) 443-4150



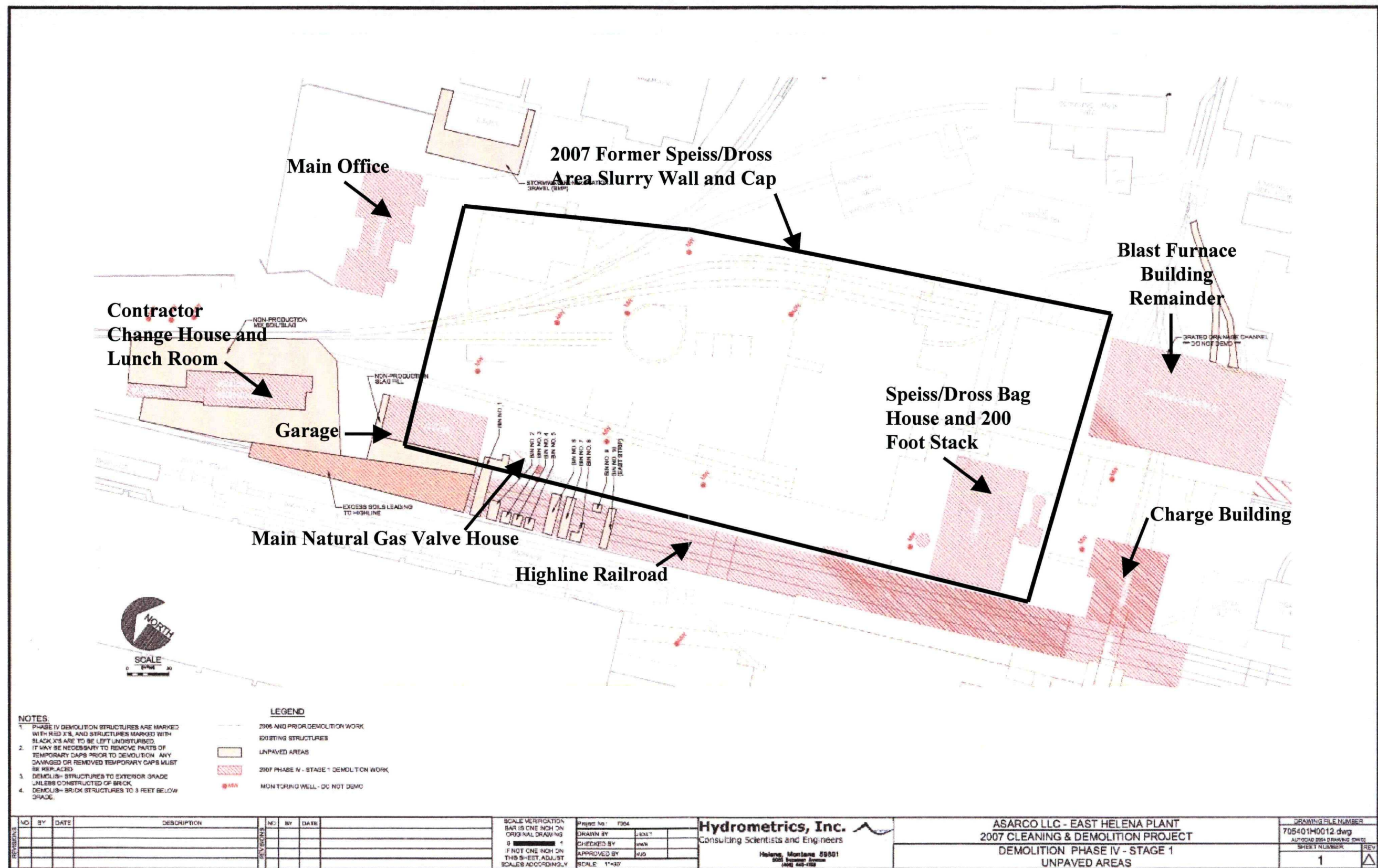


Figure 1-2. Speiss-Dross Area Slurry Wall Cleaning and Demolition Areas



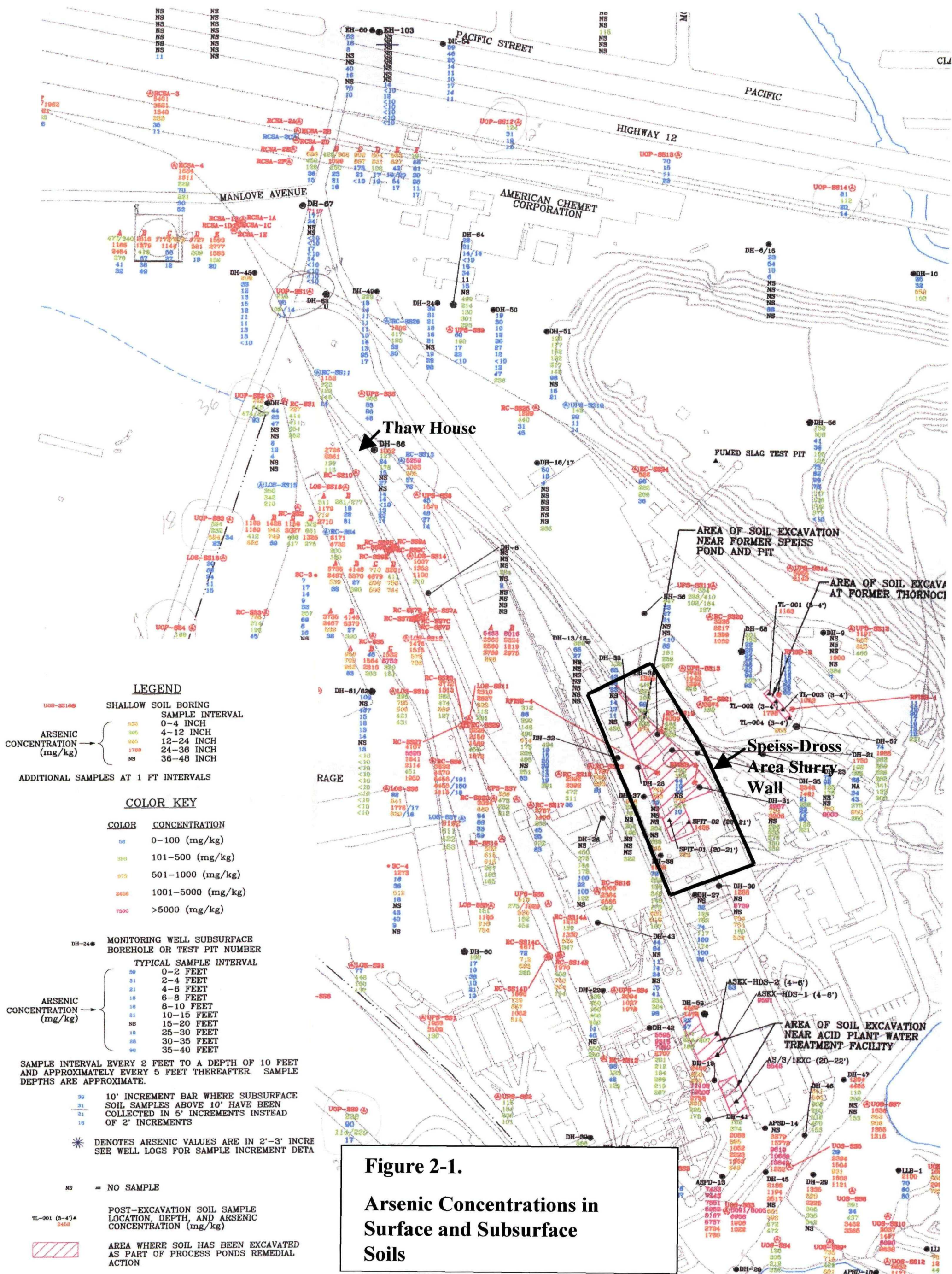


Figure 2-1.

Arsenic Concentrations in Surface and Subsurface Soils

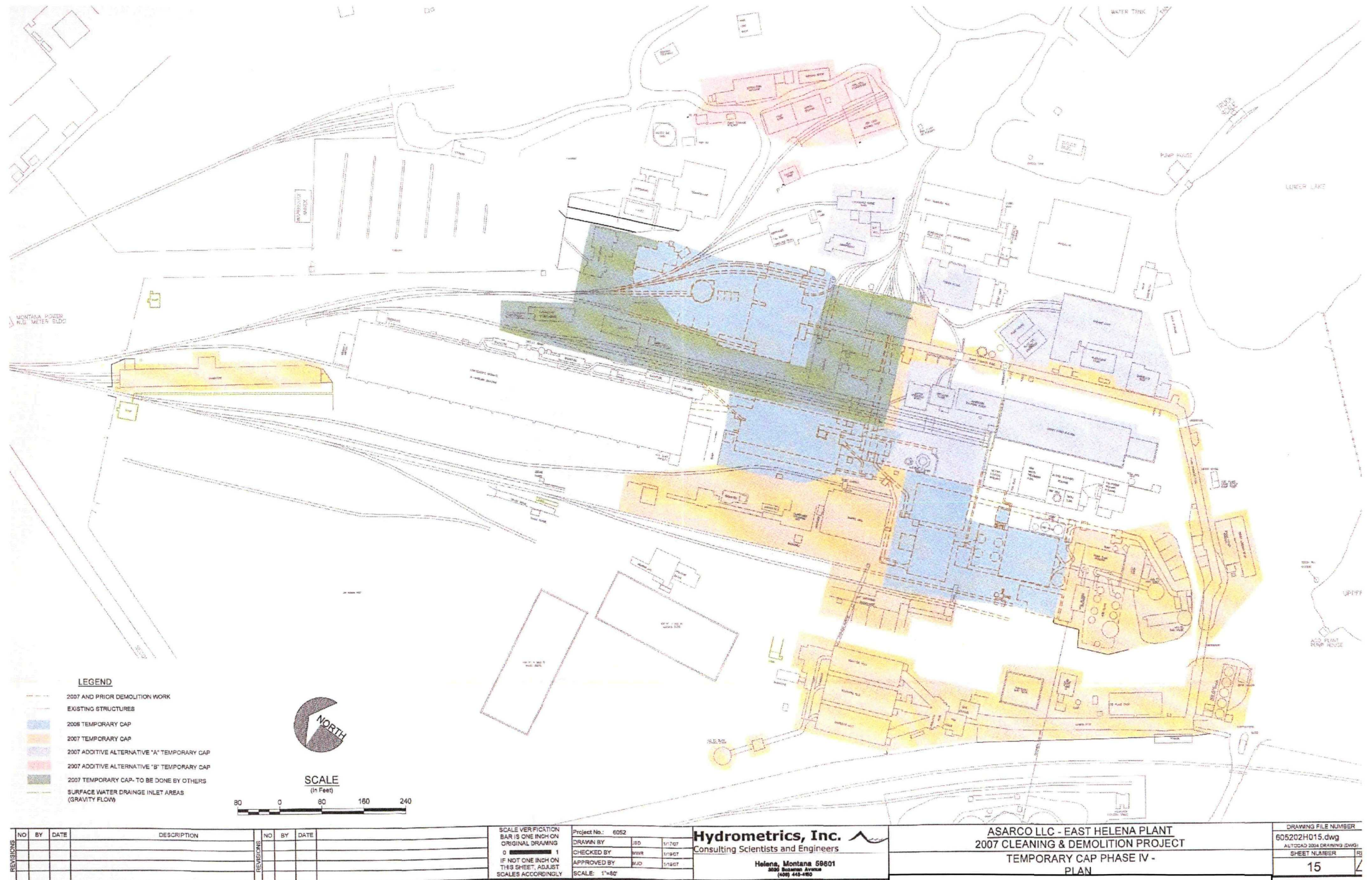
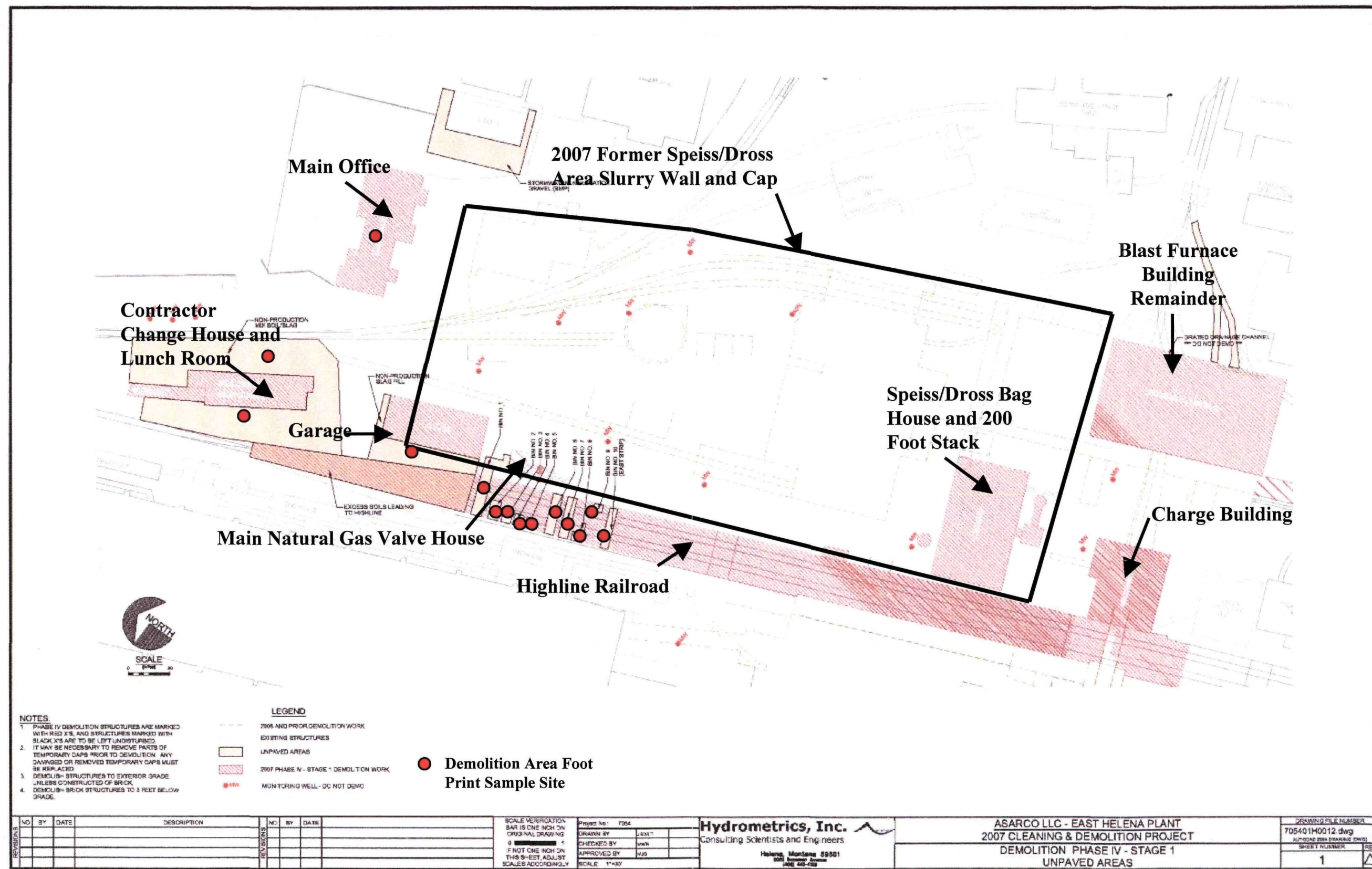
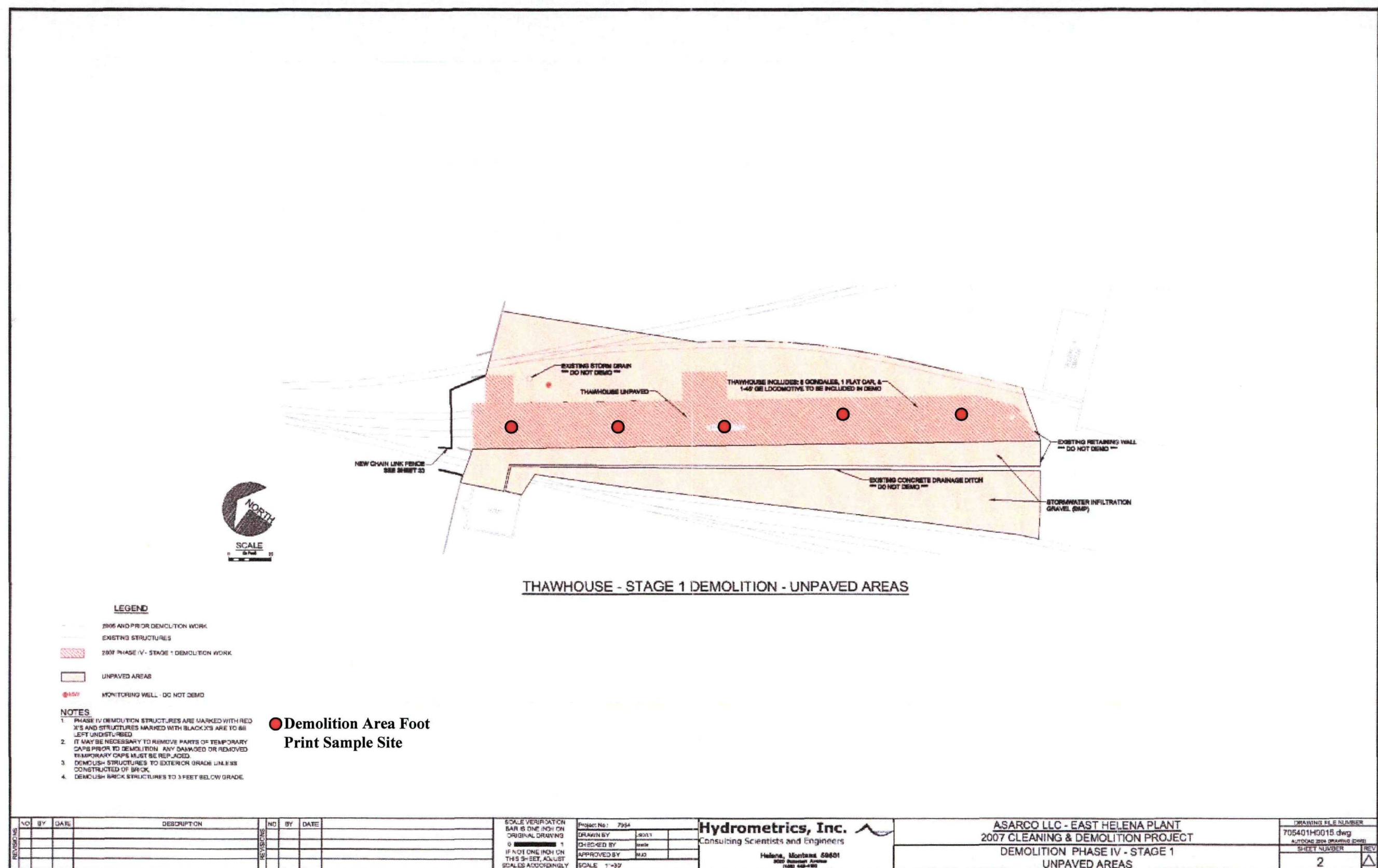


Figure 2-2. Temporary Cap Plan for Comprehensive Cleaning and Demolition



**Figure 2-3. Speiss-Dross Area
Demolition Footprint Exposed Soil
Sampling Sites**



**Figure 2-4. Thaw House Area
Demolition Footprint Exposed Soil
Sampling Sites**

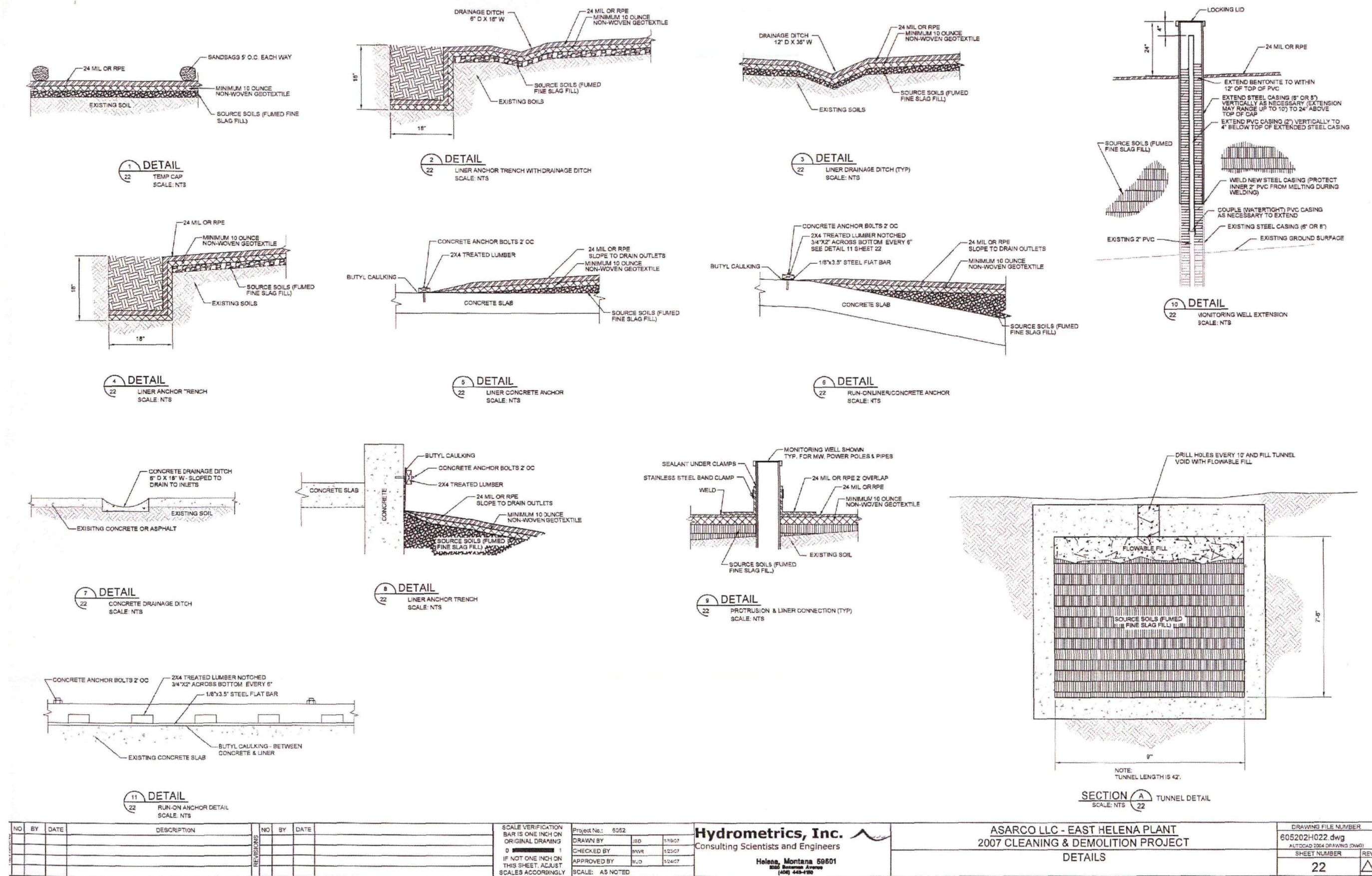
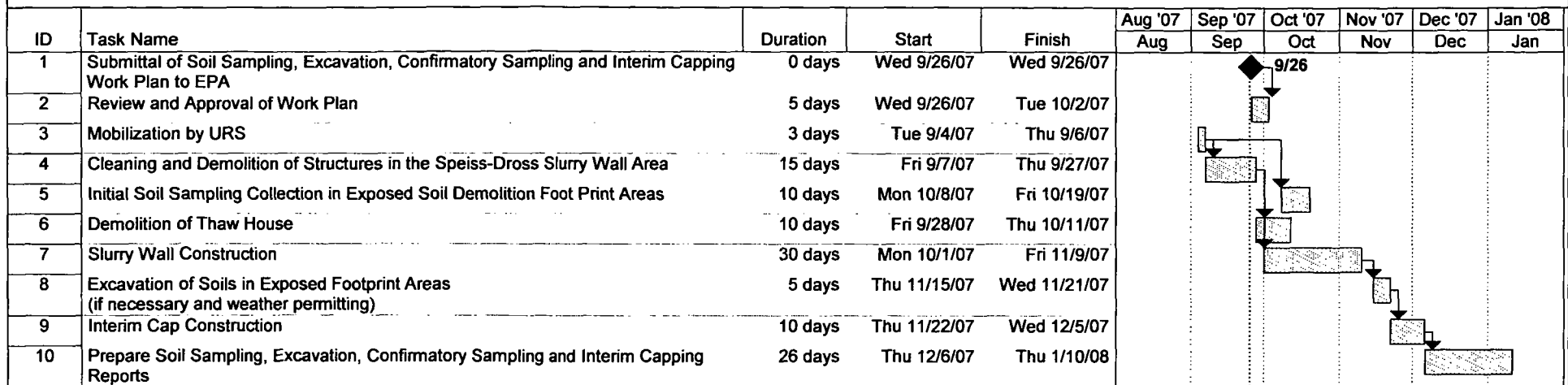


Figure. 2-5.
Temporary Cap Details




FIGURE 3-1. 2007 SOIL SAMPLING, EXCAVATION, CONFIRMATORY SAMPLING AND INTERIM CAPPING WORK PLAN SCHEDULE



Project: f07 Demolition Fig 3-1-Rev 00
Date: Tue 9/25/07

Task 
Split 
Progress 

Milestone 
Summary 
Project Summary 

External Tasks 
External Milestone 
Deadline 

APPENDIX A

SURFACE AND SUBSURFACE SOIL SAMPLE DATA FOR LOCATIONS NEAR OR ADJACENT TO THE SPEISS-DROSS AND THAWHOUSE AREAS

ASARCO EAST HELENA RFI SOIL SAMPLING

SITE: UPS-SS06

Date	Time	Sample Code	Depth Interval	Description	Concentrations				
					As	Cd	Cu	Pb	Zn
03/20/01	1300	UPS-SS06-1	0-5"	Brown sand and gravel; few fines; sand is fine to coarse (mostly coarse); moist.	45	92	179	630	350
	1305	UPS-SS06-2	5-18"	Black coarse sand with gravel; 10% fines; moist; some thin red clay zones in areas, 20% small gravel.	1879	701	3892	24682	18867
	1310	UPS-SS06-3	18-28"	Red crumbled brick layer; pieces range from fine sand to small gravel; dry.	48	28	154	694	605
	1315	UPS-SS06-4	28-35"	Black/white ash/porous red slag like material; varying sizes up to large gravels.	27	17	133	945	532
	1320	UPS-SS06-5	35-48"	Light brown sandy silt with <20% pea gravels (close to native soil texture).	14	<10	43	110	103

ASARCO EAST HELENA RFI SOIL SAMPLING

SITE: UPS-SS08

Date	Time	Sample Code	Depth Interval	Description	Concentrations				
					As	Cd	Cu	Pb	Zn
03/15/01	1215	UPS-SS08-1	0-4"	Dark brown to gray sand and gravel; road fill with minor clay.	203	80	787	2624	1347
	1220	UPS-SS08-2	4-12"	Dark brown sandy silt with >20% gravel; moist; gravels decreasing with depth.	83	48	259	1169	828
	1225	UPS-SS08-3	12-24"	Dark brown sandy silt with <20% gravel and intermittent; 1" thick clay lenses; dense; compacted; moist.	80	33	148	913	612
	1230	UPS-SS08-4	24-36"	Dark brown sandy silt with <20% gravel and intermittent; 1" thick clay lenses; dense; compacted; moist.	48	28	147	722	493

ASARCO EAST HELENA RFI SOIL SAMPLING

SITE: UPS-SS13

Date	Time	Sample Code	Depth Interval	Description	Concentrations				
					As	Cd	Cu	Pb	Zn
03/20/01	0900	UPS-SS13-1	0-4"	Gray to black road gravels and sand; 50% rounded coarse sand; 10% fines; moist.	1748	843	8221	14989	8045
	0905	UPS-SS13-2	4-12"	Same as above increasing moisture with depth fines approximately 10%; 30% gravels; 50% medium to coarse sand; gravels are more angular.	1924	501	7438	14334	9131
	0910	UPS-SS13-3	12-20"	Black to bright orange discolored slag; less dense and less heavy than typical plant slag (not porous, looks more like obsidian).	1894	312	7092	19676	13821
	0915	UPS-SS13-4	20-36"	Black to bright orange discolored slag; less dense and less heavy than typical plant slag (not porous, looks more like obsidian).	415	50	1695	9636	41455

ASARCO EAST HELENA RFI SOIL SAMPLING

SITE: LOS-SS14

Date	Time	Sample Code	Depth Interval	Description	Concentrations				
					As	Cd	Cu	Pb	Zn
03/15/01	1300	LOS-SS14-1	0-4"	Dark brown fine to coarse sand and gravel in a silty clay matrix; 50% sand and gravel, moist.	1007	277	1522	7975	4387
	1305	LOS-SS14-2	4-12"	Dark brown fine to coarse sand and gravel; minor silt and clay; 75% coarse sand; moist; intermittent cement brick pieces.	1353	441	1888	15362	6263
	1310	LOS-SS14-3	12-24"	Dark brown fine to coarse sand with gravel; gravel <20%; very few fines; sporadic cement chunks - gravel size.	1100	661	1213	12027	10971
	1315	LOS-SS14-4	24-36"	Same as above with more fines, 75% coarse, 25% silt/clay.	210	40	425	1760	1715

ASARCO EAST HELENA RFI SOIL SAMPLING

SITE: LOS-SS16

Date	Time	Sample Code	Depth Interval	Description	Concentrations				
					As	Cd	Cu	Pb	Zn
03/15/01	1045	LOS-SS16-1	0-4"	Black grading to brown sandy gravel road fill; moist.	311	109	1247	2675	7529
	1050	LOS-SS16-2	4-12"	Gray to brown large gravels with minor sand and intermittent lenses of clayey sand (sand is coarse grained); fill.	1179	628	2736	10217	15239
	1055	LOS-SS16-3	12-24"	Light brown clayey sandy silt with intermittent black coarse sand lenses; sand less abundant at depth; <10% gravel; moist; lenses of tan to light brown clay; moist; 2-4" thick.	719	356	762	3527	4796
	1100	LOS-SS16-4	24-36"	Light brown clayey sandy silt with intermittent black coarse sand lenses; sand less abundant at depth; <10% gravel; moist; lenses of tan to light brown clay; moist; 2-4" thick.	2710	564	1986	12936	9604

ASARCO EAST HELENA RFI SOIL SAMPLING

SITE: LOS-SS16A

Date	Time	Sample Code	Depth Interval	Description	Concentrations				
					As	Cd	Cu	Pb	Zn
05/14/01	0830	LOS-SS16A-1	0-2"	Brown, black, fine grain, 15% fine gravel, grading to brown clayey silt from 1.5 to 2.0.	276	208	797	3331	2668
	0840	LOS-SS16A-2	2-4"	Brown, very slightly clayey soft to semi firm; dry.	21	<10	40	114	96
	0850	LOS-SS16A-3	4-6"	Brown, soft to firm, nonplastic slightly moist, trace fine grain sand.	17	<10	47	127	123
	0900	LOS-SS16A-4	6-8"	As above.	15	<10	38	45	74
	0910	LOS-SS16A-5	8-10"	Brown, slightly clayey, soft trace fine gravel, dry to very slightly moist.	12	<10	23	26	55
	0920	LOS-SS16A-6	10-12"	Brown, soft to semi firm nonplastic, damp, driller started using water.	15	<10	22	17	57
	1030	LOS-SS16A-7	15-17"	Black, brown, fine to coarse sand, poorly sorted, fine to medium gravel, cobbles at 12 to 14'.	11	<10	18	17	42

ASARCO EAST HELENA RFI SOIL SAMPLING

SITE: LOS-SS16B

Date	Time	Sample Code	Depth Interval	Description	Concentrations				
					As	Cd	Cu	Pb	Zn
07/19/01	1500	LOS-SS16B-1	0-2'	0-1' - Dark brown, sandy gravelly silt; 10% sand and 10% gravels, fine to coarse grained, black slag pieces; firm; dry.	261	216	812	3361	3002
				1-2' - Light brown silt; <10% very fine sand; <5% gravels; dry; firm.					
	1515	LOS-SS16B-1D	0-2'	0-1' - Silt dark brown sandy gravelly silty; 10% sand and 10% gravels, fine to coarse grained, black slag pieces; firm; dry.	277	239	868	3569	3234
				1-2' - Light brown silt; <10% very fine sand; <5% gravels; dry; firm.					
	1530	LOS-SS16B-2	2-4'	Light brown, sandy silt/silty sand; very fine sand; varying degrees of sand vs. silt throughout sample; dry; firm. Increasing clay content with depth.	18	<10	23	47	88
	1600	LOS-SS16B-3	4-6'	Light brown, silty clay; firm; dry; dense.	22	<10	35	29	69
	1615	LOS-SS16B-4	10-12'	Same as above; however, moist. At 12' driving a basalt cobble, basalt cobble cuttings in spoon.	81	<10	24	25	66

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-11-6T	DH-11-7T	DH-11-7T	DH-11-1
SAMPLE DATE	12/21/1987	12/21/1987	12/21/1987	11/01/1986
LAB	TSC-SLC	VERSR	TSC-SLC	RMAL
LAB NUMBER	88-385		88-380	
REMARKS		SPLIT		SPLIT
DEPTH	3-4'	4-5'	4-5'	10-10.5'
SAMPLE NUMBER	HYD-8850	HYD-7931.A14	HYD-8851	HYD-7933.A14
-- PHYSICAL PARAMETERS --				
PH	8.5		8.3	
-- MAJOR CONSTITUENTS --				
MAGNESIUM (MG) DIS		2010.0		
SODIUM (NA) DIS		103.0		
POTASSIUM (K) DIS		880.0		
-- METALS & MINOR CONSTITUENTS --				
ARSENIC (AS) TOT	22.0		6.0	
CADMIUM (CD) TOT	4.3		<0.5	
COPPER (CU) TOT	46.0	16.0	17.0	122.0
IRON (FE) TOT	9968.0	10200.0	11073.0	29500.0
LEAD (PB) TOT	324.0	23.0	18.0	250.0
MANGANESE (MN) TOT	625.0	253.0	216.0	615.0
MERCURY (HG) TOT		0.1		
NICKEL (NI) TOT		5.4		
ZINC (ZN) TOT	420.0		33.0	
-- OTHER PARAMETERS --				
COARSE FRAGMENTS (%)	60.9		64.78	

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-13-1T	DH-13-1T	DH-13-2	DH-13-2T
SAMPLE DATE	12/22/1987	12/22/1987	11/01/1986	12/22/1987
LAB	VERSR	TSC-SLC	RMAL	TSC-SLC
LAB NUMBER		88-326		88-322
REMARKS	SPLIT		SPLIT	
DEPTH	0-0.3'	0-0.3'	15-15.5'	0.3-1'
SAMPLE NUMBER	HYD-7943.A14	HYD-8858	HYD-7934.A14	HYD-8859

-- PHYSICAL PARAMETERS --

PH	6.7	6.8
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-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	3610.0
SODIUM (NA) DIS	2970.0
POTASSIUM (K) DIS	2950.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	3163.0	389.0
CADMIUM (CD) TOT	1610.0	84.0
COPPER (CU) TOT	17100.0	43.0
IRON (FE) TOT	86600.0	15200.0
LEAD (PB) TOT	33400.0	20.0
MANGANESE (MN) TOT	2070.0	407.0
MERCURY (HG) TOT	22.0	
NICKEL (NI) TOT	191.0	
ZINC (ZN) TOT	14450.0	5868.0

-- OTHER PARAMETERS --

COARSE FRAGMENTS (%)	29.71	40.34
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NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

	SITE CODE	DH-13-3	DH-13-3T	DH-13-3T	DH-13-3T	DH-13-3T
SAMPLE DATE	11/01/1986		12/22/1987	12/22/1987	12/22/1987	12/23/1987
LAB	RMAL		VERSR	TSC-SLC	TSC-SLC	VERSR
LAB NUMBER				88-330	88-325	
REMARKS	SPLIT		SPLIT	DUPLICATE		SPLIT-DUP
DEPTH	20-21.5'		1-2'	1-2'	1-2'	1-2'
SAMPLE NUMBER	HYD-7935.A14		HYD-7946.A14	HYD-7952	HYD-8860	HYD-7953.A14
-- PHYSICAL PARAMETERS --						
	PH			6.7	6.9	
-- MAJOR CONSTITUENTS --						
	MAGNESIUM (MG) DIS		3170.0			2630.0
	SODIUM (NA) DIS		3120.0			2480.0
	POTASSIUM (K) DIS		1670.0			1340.0
-- METALS & MINOR CONSTITUENTS --						
	ARSENIC (AS) TOT			28.0	28.0	*
	CADMIUM (CD) TOT			2.2	2.1	
	COPPER (CU) TOT	58.0	86.0	91.0	88.0	184.0
	IRON (FE) TOT	16000.0	24400.0	20690.0	22770.0	18500.0
	LEAD (PB) TOT	31.0	213.0	127.0	209.0	* 233.0
	MANGANESE (MN) TOT	712.0	73.0	54.0	66.0	70.0
	MERCURY (HG) TOT		0.11			0.11
	NICKEL (NI) TOT		30.0			25.0
	ZINC (ZN) TOT			126.0	112.0	
-- OTHER PARAMETERS --						
	COARSE FRAGMENTS (%)			73.77	65.67	

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-13-4	DH-13-4	DH-13-4	DH-13-4	DH-13-4	DH-13-4
SAMPLE DATE	11/01/1986	11/01/1986	11/01/1986	11/01/1986	11/01/1986	11/01/1986
LAB	LKS	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	1156	87-2472	87-2473	87-2474	87-2475	87-2476
REMARKS		WATER AMMONIUM ACETAT	HYDROXYLACHLORI	HYDROGEN PEROXI	HYDRAZINE CHLOR	
TYPE		SEQ EX	SEQ EX	SEQ EX	SEQ EX	SEQ EX
DEPTH	25-25.5	25-25.5'	25-25.5'	25-25.5'	25-25.5'	25-25.5'
SAMPLE NUMBER	HYD-7550	HYD-7669	HYD-7671	HYD-7673	HYD-7675	HYD-7677

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) DIS	0.3	1.6	1.9	2.2	8.4	
CADMIUM (CD) DIS	0.09	0.1	0.03	0.04	0.01	
COPPER (CU) DIS	<0.05	0.18	0.06	1.52	<0.05	
IRON (FE) DIS	0.23	9.2	15.6	2.7	82.0	
LEAD (PB) DIS	<0.1	0.96	0.42	0.15	0.15	
MANGANESE (MN) DIS	32.5	12.0	0.95	0.68	0.62	
ZINC (ZN) DIS	8.6	6.8	1.2	2.6	2.5	

-- HYDROCARBONS & ORGANICS --

OIL & GREASE	350.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-13-4	DH-13-4	DH-13-4	DH-13-5	DH-13-5
SAMPLE DATE	11/01/1986	11/01/1986	11/01/1986	11/02/1986	11/02/1986
LAB	TSC-SLC	RMAL	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	87-2477			87-2478	87-2479
REMARKS	RESIDUE	SPLIT		WATER AMMONIUM ACETAT	
TYPE	SEQ EX			SEQ EX	SEQ EX
DEPTH	25-25.5'	25-25.5'	25-25.5'	30-31.5'	30-31.5'
SAMPLE NUMBER	HYD-7678	HYD-7936.A14	HYD-8852.A16	HYD-7679	HYD-7681

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) DIS	29.0			0.44	0.72
ARSENIC (AS) TOT			1434.0		
CADMIUM (CD) DIS	<0.01			4.55	17.0
CADMIUM (CD) TOT			10.15		
COPPER (CU) DIS	3.4			<0.05	0.23
COPPER (CU) TOT		40.0	200.0		
IRON (FE) DIS	1400.0			<0.1	3.3
IRON (FE) TOT		18200.0	40478.0		
LEAD (PB) DIS	1.42			<0.1	0.4
LEAD (PB) TOT		47.0	119.5		
MANGANESE (MN) DIS	11.0			0.84	2.4
MANGANESE (MN) TOT		890.0	1394.0		
ZINC (ZN) DIS	9.8			1.7	8.3
ZINC (ZN) TOT			1013.0		

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-13-5	DH-13-5	DH-13-5	DH-13-5	DH-13-5	DH-13-5
SAMPLE DATE	11/02/1986	11/02/1986	11/02/1986	11/02/1986	11/02/1986	11/02/1986
LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	RMAL	TSC-SLC
LAB NUMBER	87-2480	87-2481	87-2482	87-2483		
REMARKS	HYDROXYLACHLORI	HYDROGEN PEROXI	HYDRAZINE CHLOR	RESIDUE	SPLIT	
TYPE	SEQ EX	SEQ EX	SEQ EX	SEQ EX		
DEPTH	30-31.5'	30-31.5'	30-31.5'	30-31.5'	30-31.5'	30-31.5'
SAMPLE NUMBER	HYD-7683	HYD-7685	HYD-7687	HYD-7688	HYD-7939.A14	HYD-8853.A16

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) DIS	1.2	0.66	0.9	4.8		
ARSENIC (AS) TOT						299.5
CADMIUM (CD) DIS	0.66	3.55	0.26	0.46		
CADMIUM (CD) TOT						1142.0
COPPER (CU) DIS	0.06	6.5	<0.05	4.0		
COPPER (CU) TOT					554.0	439.5
IRON (FE) DIS	4.7	0.55	65.0	1625.0		
IRON (FE) TOT					10000.0	44303.0
LEAD (PB) DIS	0.12	0.11	0.15	0.86		
LEAD (PB) TOT					15.0	60.5
MANGANESE (MN) DIS	0.36	0.07	0.3	11.5		
MANGANESE (MN) TOT					124.0	454.5
ZINC (ZN) DIS	1.4	3.4	3.1	16.2		
ZINC (ZN) TOT						1236.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-13-5T	DH-13-6	DH-13-6	DH-13-6	DH-13-6
SAMPLE DATE	12/22/1987	11/02/1986	11/02/1986	11/02/1986	11/02/1986
LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	88-329	87-2484	87-2485	87-2486	87-2487
REMARKS		WATER	AMMONIUM	ACETAT	HYDROXYLACHLORI
TYPE		SEQ EX	SEQ EX	SEQ EX	SEQ EX
DEPTH	2-3'	35-36'	35-36'	35-36'	35-36'
SAMPLE NUMBER	HYD-8855	HYD-7689	HYD-7691	HYD-7693	HYD-7695

-- PHYSICAL PARAMETERS --

PH	6.9
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-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) DIS	1.2	2.8	2.1	1.9
ARSENIC (AS) TOT	65.0			
CADMIUM (CD) DIS	0.14	2.45	1.2	100.0
CADMIUM (CD) TOT	3.0			
COPPER (CU) DIS	<0.05	<0.05	<0.05	0.55
COPPER (CU) TOT	75.0			
IRON (FE) DIS	0.18	1.7	3.3	0.4
IRON (FE) TOT	15490.0			
LEAD (PB) DIS	<0.1	0.11	<0.1	<0.1
LEAD (PB) TOT	273.0			
MANGANESE (MN) DIS	0.08	2.15	0.07	0.11
MANGANESE (MN) TOT	166.0			
ZINC (ZN) DIS	0.35	13.8	2.0	47.5
ZINC (ZN) TOT	111.0			

-- OTHER PARAMETERS --

COARSE FRAGMENTS (%)	48.11
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NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-13-6	DH-13-6	DH-13-6	DH-13-6	DH-13-6T
SAMPLE DATE	11/02/1986	11/02/1986	11/02/1986	11/02/1986	12/22/1987
LAB	TSC-SLC	TSC-SLC	RMAL	TSC-SLC	TSC-SLC
LAB NUMBER	87-2488	87-2489			88-328
REMARKS	HYDRAZINE CHLOR	RESIDUE	SPLIT		
TYPE	SEQ EX	SEQ EX			
DEPTH	35-36'	35-36'	35-36'	35-36'	3-4'
SAMPLE NUMBER	HYD-7697	HYD-7698	HYD-7940.A14	HYD-8854.A16	HYD-8856

-- PHYSICAL PARAMETERS --

PH	7.6
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-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) DIS	5.3	26.0			
ARSENIC (AS) TOT				1270.0	32.0
CADMIUM (CD) DIS	0.09	5.65			
CADMIUM (CD) TOT				5330.0	1.4
COPPER (CU) DIS	<0.05	4.1			
COPPER (CU) TOT			71.0	130.0	25.0
IRON (FE) DIS	190.0	2150.0			
IRON (FE) TOT			31700.0	63522.0	12548.0
LEAD (PB) DIS	0.12	1.06			
LEAD (PB) TOT			12.0	43.0	63.0
MANGANESE (MN) DIS	3.3	18.0			
MANGANESE (MN) TOT			402.0	732.5	222.0
ZINC (ZN) DIS	5.5	22.5			
ZINC (ZN) TOT				3957.0	52.0

-- OTHER PARAMETERS --

COARSE FRAGMENTS (%)	41.31
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NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-13-7	DH-13-7T	DH-13-7T	DH-13-8
SAMPLE DATE	11/03/1986	12/22/1987	12/22/1987	11/03/1986
LAB	RMAL	VERSR	TSC-SLC	RMAL
LAB NUMBER			88-333	
REMARKS	SPLIT	SPLIT		SPLIT
DEPTH	40-41'	4-5'	4-5'	45-46.5'
SAMPLE NUMBER	HYD-7941.A14	HYD-7951.A14	HYD-8857	HYD-7942.A14

-- PHYSICAL PARAMETERS --

PH	8.0
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-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	6450.0
SODIUM (NA) DIS	330.0
POTASSIUM (K) DIS	2110.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	27.0
CADMIUM (CD) TOT	0.6
COPPER (CU) TOT	31.0
IRON (FE) TOT	17400.0
LEAD (PB) TOT	86.0
MANGANESE (MN) TOT	233.0
MERCURY (HG) TOT	0.11
NICKEL (NI) TOT	9.4
ZINC (ZN) TOT	42.0

-- OTHER PARAMETERS --

COARSE FRAGMENTS (%)	46.62
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NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
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 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-24-11	DH-26-0	DH-26-1
SAMPLE DATE	04/30/1987	04/28/1987	04/26/1987
LAB	VERSR	LKS	TSC-SLC
LAB NUMBER		4532	87-4442
REMARKS	SPLIT-DUPLICATE		
DEPTH	35-36'		2-3.5'
SAMPLE NUMBER	HYD-8066.A14	HYD-7549	HYD-8068

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	8250.0
SODIUM (NA) DIS	329.0
POTASSIUM (K) DIS	5370.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT		450.0
CADMIUM (CD) TOT		60.0
COPPER (CU) TOT	68.0	350.0
IRON (FE) TOT	27200.0	25500.0
LEAD (PB) TOT	44.0	3600.0
MANGANESE (MN) TOT	1300.0	520.0
MERCURY (HG) TOT	0.11	
NICKEL (NI) TOT	17.0	
ZINC (ZN) TOT		1300.0

-- VOLATILE ORGANICS --

1,1,1-TRICHLOROETHANE	<0.003
1,1,2,2-TETRACHLOROETHANE	<0.003
1,1,2-TRICHLOROETHANE	<0.003
1,1-DICHLOROETHANE	<0.003
1,1-DICHLOROETHENE	<0.003
1,2-DICHLOROETHANE	<0.003
1,2-DICHLOROPROPANE	<0.003
2-BUTANONE (METHYL-ETHYL-KETONE)	<0.003
2-CHLOROETHYL VINYL ETHER	<0.003
2-HEXANONE	<0.003
4-METHYL-2-PENTANONE	<0.003
ACETONE	<0.003
ACROLEIN	<0.015
ACRYLONITRILE	<0.015
BENZENE	<0.003
BROMODICHLOROMETHANE	<0.003
BROMOFORM	<0.003
BROMOMETHANE	<0.003
CARBON DISULFIDE	<0.003
CARBON TETRACHLORIDE	<0.003
CHLOROBENZENE	<0.003
CHLOROETHANE	<0.003
CHLOROFORM	<0.003
CHLOROMETHANE	<0.003
CIS-1,3-DICHLOROPROPENE	<0.003
ETHYLBENZENE	<0.003
TOTAL XYLENE TOT	<0.003
STYRENE	<0.003
TETRACHLOROETHENE	<0.003
TOLUENE	<0.003
TRANS-1,2-DICHLOROETHENE	<0.003
TRANS-1,3-DICHLOROPROPENE	<0.003
TRICHLOROETHENE	<0.003
VINYL ACETATE	<0.003

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
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 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-24-11	DH-26-0	DH-26-1
SAMPLE DATE	04/30/1987	04/28/1987	04/26/1987
LAB	VSRSR	LKS	TSC-SLC
LAB NUMBER		4532	87-4442
REMARKS	SPLIT-DUPLICATE		
DEPTH	35-36'		2-3.5'
SAMPLE NUMBER	HYD-8066.A14	HYD-7549	HYD-8068

-- VOLATILE ORGANICS --

VINYL CHLORIDE

<0.003

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-26-2	DH-26-3	DH-26-3	DH-26-4
SAMPLE DATE	04/28/1987	04/28/1987	04/28/1987	04/28/1987
LAB	TSC-SLC	TSC-SLC	VERSR	TSC-SLC
LAB NUMBER	87-4445	87-4447		87-4444
REMARKS			SPLIT	
DEPTH	4-5.5'	6-7'	6-7'	8-9.5'
SAMPLE NUMBER	HYD-8069	HYD-8070	HYD-8075.A14	HYD-8071

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	4680.0
SODIUM (NA) DIS	614.0
POTASSIUM (K) DIS	1200.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	275.0	164.0		172.0
CADMIUM (CD) TOT	1.5	2.5		1.0
COPPER (CU) TOT	14.0	28.0	40.0	30.0
IRON (FE) TOT	9000.0	23000.0	12200.0	19000.0
LEAD (PB) TOT	23.0	105.0	73.0	21.0
MANGANESE (MN) TOT	160.0	250.0	247.0	245.0
MERCURY (HG) TOT			0.23	
NICKEL (NI) TOT			8.4	
ZINC (ZN) TOT	38.0	100.0		43.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-26-5	DH-26-6	DH-26-7	DH-26-7
SAMPLE DATE	04/28/1987	04/28/1987	04/28/1987	04/28/1987
LAB	TSC-SLC	TSC-SLC	TSC-SLC	VERSR
LAB NUMBER	87-4443	87-4446	87-4448	
REMARKS				SPLIT
DEPTH	10-11.5'	15-16'	20-21.5'	20-21.5'
SAMPLE NUMBER	HYD-8072	HYD-8073	HYD-8074	HYD-8076.A14

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS		2830.0
SODIUM (NA) DIS		317.0
POTASSIUM (K) DIS		1820.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	100.0	92.0	100.0	
CADMIUM (CD) TOT	2.5	1.0	1.5	
COPPER (CU) TOT	48.0	65.0	90.0	62.0
IRON (FE) TOT	28000.0	25500.0	21000.0	17200.0
LEAD (PB) TOT	91.0	23.0	42.0	25.0
MANGANESE (MN) TOT	360.0	330.0	1100.0	608.0
MERCURY (HG) TOT				0.1
NICKEL (NI) TOT				9.5
ZINC (ZN) TOT	100.0	62.0	81.0	

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
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 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
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-- SAMPLE TYPE: SOIL --

SITE CODE	DH-26-8	DH-26-8	DH-27-1	DH-27-2
SAMPLE DATE	04/29/1987	04/29/1987	05/01/1987	05/01/1987
LAB	LKS	TSC-SLC	TSC-SLC	TSC-SLC
LAB NUMBER	4532	87-4441	87-4460	87-4461
DEPTH	25-26'	25-26'	2-3.5'	4-5.5'
SAMPLE NUMBER	HYD-7553	HYD-8077	HYD-8078	HYD-8079

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	122.0	32.0	132.0
CADMIUM (CD) TOT	5.0	0.75	1.5
COPPER (CU) TOT	74.0	63.0	76.0
IRON (FE) TOT	28500.0	28000.0	28500.0
LEAD (PB) TOT	440.0	9.0	22750.0
MANGANESE (MN) TOT	650.0	455.0	1800.0
ZINC (ZN) TOT	425.0	140.0	105.0

-- VOLATILE ORGANICS --

BENZENE	<0.01
CHLOROBENZENE	<0.01
ETHYLBENZENE	<0.01
M-P XYLENE	<0.01
O-XYLENE	<0.01
TOLUENE	<0.01

-- SEMI-VOLATILE EXTRACTABLES --

1,2-DICHLOROBENZENE	<0.01
1,3-DICHLOROBENZENE	<0.01
1,4-DICHLOROBENZENE	<0.01

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
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-- SAMPLE TYPE: SOIL --

	DH-27-3	DH-27-3	DH-27-3	DH-27-4
SITE CODE				
SAMPLE DATE	05/01/1987	05/01/1987	05/01/1987	05/01/1987
LAB	TSC-SLC	VERSR	VERSR	TSC-SLC
LAB NUMBER	87-4462			87-4463
REMARKS		SPLIT	SPLIT-DUPLICATE	
DEPTH	6-7.5'	6-7.5'	6-7.5'	8-9.5'
SAMPLE NUMBER	HYD-8080	HYD-8087.A14	HYD-8088.A14	HYD-8081

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	1360.0	1390.0
SODIUM (NA) DIS	322.0	339.0
POTASSIUM (K) DIS	1470.0	953.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	162.0		74.0
CADMIUM (CD) TOT	2.0		1.0
COPPER (CU) TOT	35.0	45.0	42.0
IRON (FE) TOT	15500.0	23700.0	15600.0
LEAD (PB) TOT	7.0	23.0	21.0
MANGANESE (MN) TOT	135.0	189.0	214.0
MERCURY (HG) TOT		0.1	0.1
NICKEL (NI) TOT		6.4	6.3
ZINC (ZN) TOT	38.0		72.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
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 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-27-5	DH-27-6	DH-27-6	DH-27-7
SAMPLE DATE	05/01/1987	05/01/1987	05/01/1987	05/01/1987
LAB	TSC-SLC	LKS	TSC-SLC	TSC-SLC
LAB NUMBER	87-4464	4532	87-4465	87-4466
DEPTH	10-11.5'	15-16'	15-16'	20-21'
SAMPLE NUMBER	HYD-8082	HYD-7554	HYD-8083	HYD-8084

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	117.0	100.0	174.0
CADMIUM (CD) TOT	1.5	8.5	4.5
COPPER (CU) TOT	66.0	100.0	54.0
IRON (FE) TOT	40000.0	30500.0	26000.0
LEAD (PB) TOT	32.0	62.0	16.0
MANGANESE (MN) TOT	950.0	1600.0	185.0
ZINC (ZN) TOT	130.0	390.0	1500.0

-- SEMI-VOLATILE EXTRACTABLES --

1,2,4-TRICHLOROBENZENE	<0.056
1,2-DICHLOROBENZENE	<0.056
1,2-DIPHENYLHYDRAZINE (AZOBENZENE)	<0.056
1,3-DICHLOROBENZENE	<0.056
1,4-DICHLOROBENZENE	<0.056
2,4,5-TRICHLOROPHENOL	<0.056
2,4,6-TRICHLOROPHENOL	<0.056
2,4-DICHLOROPHENOL	<0.056
2,4-DIMETHYLPHENOL	<0.056
2,4-DINITROPHENOL	<0.056
2,4-DINITROTOLUENE	<0.056
2,6-DINITROTOLUENE	<0.056
2-CHLORONAPHTHALENE	<0.056
2-CHLOROPHENOL	<0.056
2-METHYLNAPHTHALENE	<0.056
2-METHYLPHENOL (O-CRESOL)	<0.056
2-NITROANILINE	<0.056
2-NITROPHENOL	<0.056
3,3'-DICHLOROBENZIDINE	<0.056
3-NITROANILINE	<0.056
4,6-DINITRO-O-CRESOL	<0.056
4-BROMOPHENYL PHENYL ETHER	<0.056
4-CHLORO-M-CRESOL	<0.056
4-CHLOROANILINE	<0.056
4-CHLOROPHENYL PHENYL ETHER	<0.056
4-METHYLPHENOL (P-CRESOL)	<0.056
4-NITROANILINE	<0.056
4-NITROPHENOL	<0.056
ACENAPHTHENE	<0.056
ACENAPHTHYLENE	<0.056
ANILINE	<0.056
ANTHRACENE	<0.056
BENZIDINE	<0.056
BENZO (A) ANTHRACENE	<0.056
BENZO (A) PYRENE	<0.056
BENZO (B) FLUORANTHENE	<0.056
BENZO (GHI) PERYLENE	<0.056
BENZO (K) FLUORANTHENE	<0.056
BENZOIC ACID	<0.056
BENZYL ALCOHOL	<0.056
BIS (2-CHLOROETHOXY) METHANE	<0.056
BIS (2-CHLOROETHYL) ETHER	<0.056

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
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 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-27-5	DH-27-6	DH-27-6	DH-27-7
SAMPLE DATE	05/01/1987	05/01/1987	05/01/1987	05/01/1987
LAB	TSC-SLC	LKS	TSC-SLC	TSC-SLC
LAB NUMBER	87-4464	4532	87-4465	87-4466
DEPTH	10-11.5'	15-16'	15-16'	20-21'
SAMPLE NUMBER	HYD-8082	HYD-7554	HYD-8083	HYD-8084

-- SEMI-VOLATILE EXTRACTABLES --

BIS (2-CHLOROISOPROPYL) ETHER	<0.056
BIS (2-ETHYLHEXYL) PHTHALATE	0.33
BUTYL BENZYL PHTHALATE	<0.056
CHRYSENE	<0.056
DI-N-OCTYLPHTHALATE	<0.056
DIBENZ (A,H) ANTHRACENE	<0.056
DIBENZOFURAN	<0.056
DIBUTYLPHTHALATE	<0.056
DIETHYLPHTHALATE	<0.056
DIMETHYLPHTHALATE	<0.056
FLUORANTHENE	<0.056
FLUORENE	<0.056
HEXACHLOROBENZENE	<0.056
HEXACHLOROBUTADIENE	<0.056
HEXACHLOROCYCLOPENTADIENE	<0.056
HEXACHLOROETHANE	<0.056
INDENO (1,2,3-CD) PYRENE	<0.056
ISOPHORONE	<0.056
N-NITROSO-DI-N-PROPYLAMINE	<0.056
N-NITROSODIMETHYLAMINE	<0.056
N-NITROSODIPHENYLAMINE	<0.056
NAPHTHALENE	<0.056
NITROBENZENE	<0.056
PENTACHLOROPHENOL	<0.056
PHENANTHRENE	0.49
PHENOL	<0.056
PYRENE	<0.056

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
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Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-27-7	DH-27-8	DH-27-9
SAMPLE DATE	05/01/1987	05/01/1987	05/01/1987
LAB	VERSR	TSC-SLC	TSC-SLC
LAB NUMBER		87-4467	87-4468
REMARKS	SPLIT		
DEPTH	20-21'	25-26.5'	30-31.5'
SAMPLE NUMBER	HYD-8089.A14	HYD-8085	HYD-8086

-- MAJOR CONSTITUENTS --

MAGNESIUM (MG) DIS	2920.0
SODIUM (NA) DIS	373.0
POTASSIUM (K) DIS	1860.0

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	100.0	24.0
CADMIUM (CD) TOT	11.0	1.5
COPPER (CU) TOT	45.0	32.0
IRON (FE) TOT	19200.0	23000.0
LEAD (PB) TOT	26.0	14.0
MANGANESE (MN) TOT	186.0	160.0
MERCURY (HG) TOT	0.1	
NICKEL (NI) TOT	7.5	
ZINC (ZN) TOT	720.0	57.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-29S	DH-29S	DH-29S	DH-30	DH-30
SAMPLE DATE	12/11/1987	12/11/1987	12/11/1987	11/20/1999	11/20/1999
SAMPLE TIME				14:00	14:35
LAB	TSC-SLC	TSC-SLC	VERSR	EHLAB	EHLAB
LAB NUMBER				99X-05094	99X-05095
REMARKS			SPLIT		
TYPE	TOTAL	TOTAL	TOTAL	XRF	XRF
DEPTH	8-10	10-12	10-12	1-3'	3.5-5.5'
SAMPLE NUMBER	HYD-8107.A14	HYD-8108.A14	HYD-8109.A14	IMMS-9910-270	IMMS-9910-271

-- PHYSICAL PARAMETERS --

PH	6.9	6.9			
-- MAJOR CONSTITUENTS --					
MAGNESIUM (MG) DIS		3410.0			
SODIUM (NA) DIS		658.0			
POTASSIUM (K) DIS		1990.0			
-- METALS & MINOR CONSTITUENTS --					
ARSENIC (AS) TOT	335.0	342.0	1288.0	6739.0	
CADMIUM (CD) TOT	40.0	27.0	234.0	3011.0	
COPPER (CU) TOT	578.0	1058.0	699.0	4970.0	
IRON (FE) TOT	18610.0	45325.0	37000.0		
IRON (FE) (%) TOT				10.0	2.0
LEAD (PB) TOT	5070.0	9523.0	6330.0	11574.0	19549.0
MANGANESE (MN) TOT	625.0	2748.0	2190.0	3985.0	458.0
MERCURY (HG) TOT			6.6		
NICKEL (NI) TOT			12.0		
ZINC (ZN) TOT	3250.0	9350.0		26012.0	1082.0
-- OTHER PARAMETERS --					
COARSE FRAGMENTS (%)	27.13	78.47			

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-30	DH-30	DH-30	DH-30	DH-30
SAMPLE DATE	11/20/1999	11/20/1999	11/20/1999	11/21/1999	11/21/1999
SAMPLE TIME	14:40	16:00	16:45	10:30	11:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-05096	99X-05097	99X-05098	99X-05099	99X-05100
REMARKS	DUPLICATE				
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	3.5-5.5'	8-10'	10-12'	15-17'	20-22'
SAMPLE NUMBER	IMMS-9910-271D	IMMS-9910-272	IMMS-9910-273	IMMS-9910-274	IMMS-9910-275

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	6523.0	754.0	731.0	160.0	502.0
CADMIUM (CD) TOT	2855.0	1465.0	1081.0	1686.0	610.0
COPPER (CU) TOT	110.0	190.0	89.0	76.0	138.0
IRON (FE) (%) TOT	2.0	3.0	3.0	3.0	4.0
LEAD (PB) TOT	19079.0	127.0	127.0	93.0	31.0
MANGANESE (MN) TOT	426.0	318.0	694.0	2093.0	579.0
ZINC (ZN) TOT	1045.0	1175.0	1281.0	774.0	1675.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-34	DH-35	DH-35	DH-35	DH-35
SAMPLE DATE	11/04/1999	10/25/1999	10/25/1999	10/25/1999	10/25/1999
SAMPLE TIME	18:00	11:30	11:45	12:00	12:30
LAB	TSC-SLC	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	L011603048	99X-04488	99X-04489	99X-04490	99X-04491
TYPE	Seq SPLP	XRF	XRF	XRF	XRF
DEPTH	25-27'	0-2'	2-4'	4-6'	6-8'
OTHER INFO	Leach #12				
SAMPLE NUMBER	IMMS-9910-212	IMMS-9910-186	IMMS-9910-187	IMMS-9910-188	IMMS-9910-189

-- METALS & MINOR CONSTITUENTS --

	DH-34	DH-35	DH-35	DH-35	DH-35
ARSENIC (AS) TOT	0.1	2346.0	1491.0	91.0	222.0
CADMIUM (CD) TOT	<0.001	538.0	445.0	< 10.0	< 10.0
COPPER (CU) TOT		8679.0	6166.0	207.0	138.0
IRON (FE) (t) TOT		4.0	3.0	3.0	5.0
LEAD (PB) TOT		12879.0	8529.0	444.0	182.0
MANGANESE (MN) TOT		1863.0	1500.0	562.0	1354.0
ZINC (ZN) TOT	0.038	8672.0	7505.0	648.0	113.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-35	DH-35	DH-35	DH-35	DH-35
SAMPLE DATE	10/25/1999	10/25/1999	10/25/1999	10/25/1999	10/26/1999
SAMPLE TIME	14:00	14:15	14:35	15:00	16:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-04492	99X-04493	99X-04494	99X-04495	99X-04496
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	8-10'	10-12'	15-17'	20-22'	25-27'
SAMPLE NUMBER	IMMS-9910-190	IMMS-9910-191	IMMS-9910-192	IMMS-9910-193	IMMS-9910-194

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	83.0	72.0	90.0	128.0	221.0
CADMIUM (CD) TOT	< 10.0	< 10.0	< 10.0	57.0	567.0
COPPER (CU) TOT	84.0	114.0	92.0	66.0	70.0
IRON (FE) (%) TOT	4.0	3.0	3.0	3.0	3.0
LEAD (PB) TOT	38.0	56.0	41.0	42.0	26.0
MANGANESE (MN) TOT	950.0	1225.0	1552.0	875.0	517.0
ZINC (ZN) TOT	87.0	109.0	63.0	83.0	77.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1 Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected

-- SAMPLE TYPE: SOIL --

SITE CODE	DH-36	DH-36	DH-36	DH-36	DH-36	DH-36
SAMPLE DATE	10/11/1999	10/11/1999	10/12/1999	10/12/1999	10/12/1999	10/12/1999
SAMPLE TIME	16:00	16:45	17:45	9:00	11:10	11:55
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-04268	99X-04269	99X-04270	99X-04271	99X-04272	99X-04273
TYPE	XRF	XRF	XRF	XRF	XRF	XRF
DEPTH	0.5-2'	2-2.2'	4-6'	6-8'	15-16'	22-24'
SAMPLE NUMBER	IMMS-9910-143	IMMS-9910-144	IMMS-9910-145	IMMS-9910-146	IMMS-9910-147	IMMS-9910-148

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	447.0	23.0	27.0	21.0	< 10.0	88.0
CADMIUM (CD) TOT	34.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
COPPER (CU) TOT	873.0	54.0	83.0	76.0	66.0	75.0
IRON (FE) (%) TOT	4.0	3.0	4.0	4.0	5.0	3.0
LEAD (PB) TOT	4300.0	80.0	43.0	23.0	21.0	23.0
MANGANESE (MN) TOT	1739.0	643.0	2208.0	1486.0	1446.0	841.0
ZINC (ZN) TOT	28454.0	450.0	192.0	70.0	116.0	73.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (PLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL --

	DH-36	DH-36	DH-36	DH-37	DH-37
SITE CODE					
SAMPLE DATE	10/12/1999	10/12/1999	10/12/1999	11/21/1999	11/21/1999
SAMPLE TIME	13:50	15:00	15:45	17:45	18:00
LAB	EHLAB	EHLAB	EHLAB	EHLAB	EHLAB
LAB NUMBER	99X-04274	99X-04275	99X-04276	99X-05101	99X-05102
TYPE	XRF	XRF	XRF	XRF	XRF
DEPTH	24-26'	26-28'	30-32'	1-3'	3-5'
SAMPLE NUMBER	IMMS-9910-149	IMMS-9910-150	IMMS-9910-151	IMMS-9910-276	IMMS-9910-277

-- METALS & MINOR CONSTITUENTS --

	IMMS-9910-149	IMMS-9910-150	IMMS-9910-151	IMMS-9910-276	IMMS-9910-277
ARSENIC (AS) TOT	161.0	239.0	367.0	916.0	297.0
CADMIUM (CD) TOT	< 10.0	14.0	42.0	93.0	17.0
COPPER (CU) TOT	62.0	54.0	57.0	4887.0	1239.0
IRON (FE) (%) TOT	3.0	3.0	3.0	2.0	2.0
LEAD (PB) TOT	18.0	26.0	17.0	4405.0	1029.0
MANGANESE (MN) TOT	519.0	396.0	767.0	387.0	448.0
ZINC (ZN) TOT	71.0	51.0	64.0	511.0	254.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL BORINGS --

SITE CODE	DH-66S	DH-66S	DH-66S	DH-66S	DH-66S	DH-66S
SAMPLE DATE	07/22/2002	07/22/2002	07/22/2002	07/22/2002	07/22/2002	07/22/2002
SAMPLE TIME	9:00	9:10	9:20	10:20	10:50	12:00
LAB	TACLAB	TACLAB	TACLAB	TACLAB	TACLAB	TACLAB
LAB NUMBER	02R-00949	02R-00950	02R-00951	02R-00952	02R-00953	02R-00954
TYPE	EDXRF	EDXRF	EDXRF	EDXRF	EDXRF	EDXRF
DEPTH	0-2'	3-5'	6-8'	9-11'	15-17'	25-27'
OTHER INFO	SS	SS	SS	SS	SS	SS
SAMPLE NUMBER	DH-66-01	DH-66-02	DH-66-03	DH-66-04	DH-66-05	DH-66-07

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	1052.0	127.0	178.0	15.0	27.0	14.0
CADMIUM (CD) TOT	392.0	97.0	103.0	< 10.0	< 10.0	< 10.0
COPPER (CU) TOT	2472.0	535.0	508.0	45.0	49.0	77.0
IRON (FE) (%) TOT	4.0	2.0	3.0	2.0	6.0	3.0
LEAD (PB) TOT	19608.0	2569.0	3086.0	22.0	25.0	47.0
MANGANESE (MN) TOT	1330.0	393.0	508.0	402.0	495.0	624.0
ZINC (ZN) TOT	10780.0	1390.0	1911.0	88.0	42.0	53.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
 TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
 Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
 R:Rejected.

-- SAMPLE TYPE: SOIL BORINGS --

SITE CODE	DH-66S	DH-66S	DH-66S	DH-66S	DH-66S
SAMPLE DATE	07/22/2002	07/22/2002	07/22/2002	07/22/2002	07/22/2002
SAMPLE TIME	12:40	14:10	15:00	15:50	17:00
LAB	TACLAB	TACLAB	TACLAB	TACLAB	TACLAB
LAB NUMBER	02R-00955	02R-00956	02R-00957	02R-00958	02R-00959
TYPE	EDXRF	EDXRF	EDXRF	EDXRF	EDXRF
DEPTH	30-32'	35-27'	40-42'	45-57'	50-52'
OTHER INFO	SS	SS	SS	SS	SS
SAMPLE NUMBER	DH-66-08	DH-66-09	DH-66-10	DH-66-11	DH-66-12

-- METALS & MINOR CONSTITUENTS --

ARSENIC (AS) TOT	14.0	< 10.0	13.0	22.0	11.0
CADMIUM (CD) TOT	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
COPPER (CU) TOT	103.0	101.0	52.0	77.0	52.0
IRON (FE) (%) TOT	3.0	3.0	7.0	3.0	1.0
LEAD (PB) TOT	35.0	57.0	34.0	28.0	57.0
MANGANESE (MN) TOT	811.0	541.0	380.0	946.0	286.0
ZINC (ZN) TOT	96.0	84.0	39.0	32.0	108.0

NOTES: All results in mg/L (Water) or mg/kg (Soil) unless noted and are laboratory (LAB) unless field (FLD) or calculated (CALC)
TOT:Total; DIS:Dissolved; TRC:Total Recoverable; E:Estimated; <:Less Than Detect. Blank: parameter not tested
Validation Flags: A:Anomalous; UJ1:Blank; J2,UJ2: Standard; J3:Hold Time; J4,UJ4:Duplicate, Spike, or Split Exceedance;
R:Rejected.

APPENDIX B

**STANDARD OPERATING PROCEDURES (SOP)
FOR SURFACE SOIL AND SUB-SURFACE
SOIL SAMPLE COLLECTION**

**STANDARD OPERATING PROCEDURE
DETERMINATION, IDENTIFICATION, AND DESCRIPTION OF
FIELD SAMPLING SITES^o
HF-SOP-2**

1.0 PURPOSE

This Standard Operating Procedure (SOP) is to be used for locating, identifying and describing field sampling sites. The objective of this SOP is to clearly identify the sampling site location and to describe the site in such a manner as to ensure accurate site relocation for repetitive sampling.

2.0 EQUIPMENT

- Accurate map or air photo with coordinate grid
- Global Positioning System (GPS) instrument
- Colored site marker (a steel fence post, rebar, wooden stake, etc.)
- Identification tag
- Camera and film
- Detailed map

3.0 PROCEDURE

Location of field sampling sites can be reported using the following:

- Latitude-Longitude - accurate to at least 0.2 minutes and preferably to less than 0.1 minutes
- General Land Office Coordinates - see **Figure 1** (System for Geographical Location of Features) for location procedure. Location should be at least to nearest quarter-quarter section.
- State or Project Coordinates - Many project sites have a plane coordinate grid and many states have a coordinate system. Location should be as accurate as possible.
- Narrative Description - In addition to a location by latitude-longitude, coordinates, or general land office designation or coordinates, a narrative description also is valuable. Some sampling sites are so close together that they cannot be separated except by a narrative description. Such locations should be referenced by distance and azimuth from some "permanent" fixtures (large rocks), trees, buildings, etc. Additionally, an air photo or ordinary color photograph (with the site clearly marked) is very helpful in locating sites.

All field sampling sites will be identified by placement of colored site markers such as a steel fence post, rebar, wooden stake, etc. The station designation and location will be noted on an identification tag that is securely fastened to the site marker. The station designation used will be determined by the Project Manager.

For each field sampling site established, an Identification and Description of Sampling Site form (**HF-FORM-407**) will be completed. All information requested on the form will be supplied. In addition, a photograph of the site with a full description of the "view" of the photo noted (e.g. "looking downstream from bedrock outcrop 50 feet upstream of site") will be attached or mounted on the form. The sampling site will be marked on the photo and on a detailed site map.

4.0 RELATED REFERENCES

HF-FORM-407 - Identification and Description of Field Sampling Sites

SYSTEM FOR GEOGRAPHICAL LOCATION OF FEATURES

Geographic features such as sampling sites, wells and springs are assigned a location number based on the system of land subdivision used by the U.S. Bureau of Land Management. The number consists of 10 to 16 characters and describes the location by township, range, section and position within the section. The figure below illustrates this numbering method. The first three or four characters of the number give the township, the next three or four the range. The next two numbers give the section number within the township and the next letters describe the location within the quarter section (160-acre tract) and quarter-quarter section (40-acre tract). If the location is known to sufficient accuracy then one or two additional letters can be used to describe the quarter-quarter-quarter-quarter section (2 1/2-acre tract). These subdivisions of the 640-acre section are designated as A, B, C and D in a counterclockwise direction beginning in the northeast quadrant. If there is more than one feature in a tract, consecutive digits beginning with the number 1 are added to the number. For example, if a sampling site was in Section 21, Township 29 North, Range 20 West, it would be numbered 29N20W21DAAD2. The letters DAAD indicate the well is in the southeast 1/4 of the northeast 1/4 of the northeast 1/4 of the southeast 1/4 and the number 2 following the letters DAAD indicates there is more than one site location in this 2 1/2-acre tract. If geographic features are located to the nearest 40 acre or 10 acre tract, the numbering methodology is the same except the last one or two letters are absent.

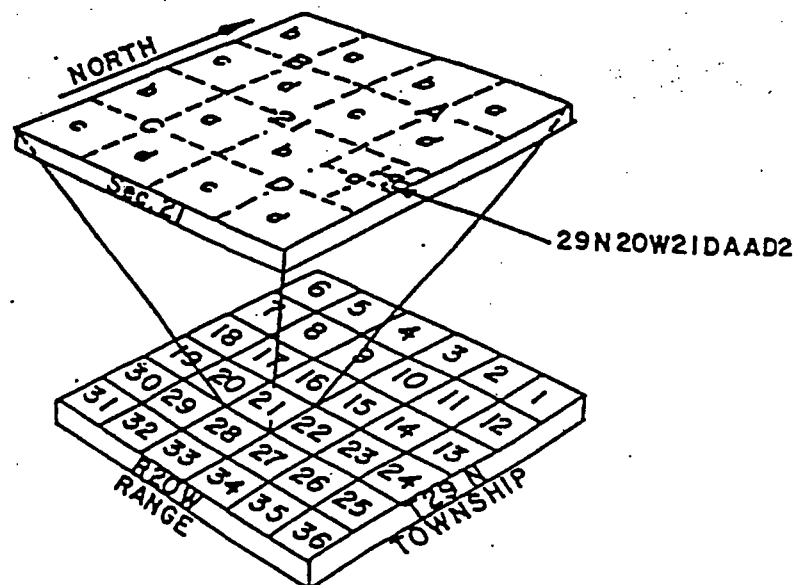


Figure 1. System for Geographical Location of Features

STANDARD OPERATING PROCEDURE FORM

IDENTIFICATION AND DESCRIPTION OF FIELD SAMPLING SITES^o
HF-FORM-407

PROJECT: _____ NUMBER: _____

SITE CODE: _____ HYDROMETRICS'
UNIQUE SITE CODE: _____NARRATIVE SITE DESCRIPTION: _____

SITE LOCATION: T _____ N S R _____ E W SEC _____ TRACT _____

LATITUDE/LONGITUDE _____ N _____ E

COORDINATES: _____

COUNTY: _____ STATE: _____

STATION TYPE: Stream Spring Well Pond Process Water Soil

OTHER: _____

REMARKS (Access, etc.): _____

(ATTACH PHOTO HERE)

DESCRIPTION OF PHOTO "VIEW": _____

DATE: _____ INDIVIDUAL (Signature): _____

ATTACH MAP OF SAMPLING SITE TO THIS FORM

STANDARD OPERATING PROCEDURE

PACKING AND SHIPPING SAMPLES

HF-SOP-4

1.0 PURPOSE

This procedure is to be followed when packing and shipping water or soil samples to the laboratory by commercial carrier. The Chain-of-Custody standard operating procedure (HF-SOP-5) also must be followed if required in the project plan.

2.0 PROCEDURE

- 2.1 All samples must be labeled and labels filled out in waterproof ink. The label can be Hydrometrics' standard shipping label or may be a project-specific label. Sample labeling procedures are detailed in **HF-SOP-29** (Labeling and Documentation of Samples).
- 2.2 All samples are placed in the shipping container - normally a metal or plastic cooler.
- 2.3 Packing:
 - 2.3.1 Sample containers are typically placed in a cooler. Other commercially available insulated containers may be used. The project manager should determine that the containers are appropriate to the type of sample being shipped.
 - 2.3.2 If trip blanks are required, typical for organics sampling, be sure one is present for each and every shipping container.
 - 2.3.3 If an ice pack is used, place the ice pack in the cooler or cooler lid as needed. Fill space with bubble mat wrap or packing material. If necessary, place bubble wrap on top of samples. Sufficient packing material should be used to prevent sample containers from contacting each other during transport.
 - 2.3.4 If custody seals are required, they will be placed on at least two places connecting the cooler container lid to the cooler.
 - 2.3.5 Coolers are then wrapped with nylon strapping tape. Two full rotations of tape will be placed at least two places on the cooler.
- 2.4 Packing and shipping procedures for Superfund facilities should follow guidelines outlined in the EPA document "A Compendium of Superfund Field Operating Methods".

3.0 SHIPPING

Samples can be sent by commercial air carrier, overnight express, Federal Express or other means. The allowable holding time and often the ability to keep samples cold are important considerations. Copies of all shipment records must be kept in the project files.

Each sample container will be marked with:

- Sampling organization name, address and telephone number;
- Laboratory name, address and telephone number; and
- Ship samples via courier following any applicable DOT requirements. The project manager should determine if there are any special shipping considerations.

3.1 Documents

Each shipping container will contain a description of samples enclosed, date of collection and date of shipment, either a cover letter or a Request for Analytical Services, and/or a Chain-of-Custody form. See Labeling and Documentation of Samples (**HF-SOP-29**).

For Chain-of-Custody shipments complete a Chain-of-Custody form (see Chain-of-Custody Standard Operating Procedure **HF-SOP-5**).

- Sign the form.
- Place two copies in zip-lock bag in sample container.
- Keep one signed copy in project file.

Signing of the Chain-of-Custody form (record) relinquishes custody of the samples. Relinquishing custody should only occur when directly shipping to the analytical laboratory.

4.0 RELATED REFERENCES

HF-SOP-5 Chain-of Custody Procedure

HF-SOP-29 Labeling and Documentation of Samples

U.S. EPA, 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA-600/4-82-029.

U.S. EPA, 1987. A Compendium of Superfund Field Operations Methods PB88-181557.

STANDARD OPERATING PROCEDURE

CHAIN-OF CUSTODY HF-SOP-5

1.0 PURPOSE

The purpose of this procedure is to maintain a chain-of-custody for samples. All soil and water samples collected and sent to the laboratory for analysis will be documented using standard chain-of-custody procedures.

2.0 CUSTODY PROCEDURE

Samples will be collected at established project sampling sites using Standard Operating Procedures (SOP). Sampling activities will be recorded in the samplers daily log book and the appropriate collection form(s) completed (see appropriate sampling SOP). Each sample container will be identified by labeling. Labels are attached to sample bottles and are protected with clear label tape to prevent abrasion of labeling information and to guard against failure of label adhesive.

2.1 Sample Identification

Each sample bottle should be labeled with the following information:

- Site;
- Sample Number;
- Person taking the sample;
- Date and time of collection;
- Sample matrix (water, soil, oil, etc.);
- Basis (total or dissolved);
- Preservation; and
- Analyses to be performed.

Labels will be written in waterproof ink.

Use of pre-printed, self-adhesive labels, if available, is preferred.

All samples must be traceable from the time the samples are collected until they are received by the analytical laboratory. The laboratory is then responsible for custody during processing and analysis.

A sample is under custody if:

- It is in your possession;
- It is in your view, after being in your possession;
- It was in your possession and then you locked it up to prevent tampering; or
- It was in your possession and then you placed it in a designated secure area.

2.2 Custody Records

Each sample is identified on a Chain-of-Custody Form(s) (**HF-FORM-001**) by its sample number, date and time of collection, and analysis requested.

Documents will consist of:

- Sample collection records;
- Chain-of-Custody form(s) (**HF-FORM-001**);
- Analytical Parameter List(s) including analytical methods and detection limits if not on the Chain-of-Custody form;
- Shipping receipt(s); and
- Purchase Order(s).

3.0 CUSTODY TRANSFER AND SHIPMENT

All samples will be accompanied by **Chain - of - Custody** record (**HF-FORM-001**). The following procedures will be followed:

- When transferring the possession of samples, the individual(s) relinquishing and receiving will sign, date and note the time on the record. This record documents sample custody transfer from the sampler to the laboratory.

- Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate custody record accompanying each shipment. Shipping containers will be sealed for shipment to the laboratory. The method of shipment, courier name(s) and other pertinent information are entered in the "Remarks" box.
- All shipments will be accompanied by the **Chain - of - Custody Record (HF-FORM-001)** identifying its contents. The original record will accompany the shipment and a copy will be retained in the project file.
- Analytical parameters requested must be noted on the Chain-of-Custody Record, or an attached analytical parameters list accompanying the Chain-of-Custody Record. If not attached to the Chain-of-Custody, an Analytical Parameter List including analytical methods and detection limits must be included with each shipment and should specify methods of analysis required for each parameter.
- All shipping receipts (next day air waybills, freight bills, post office receipts, bills of lading, etc.) purchase orders, and sample collection records will be retained in the project file.


4.0 CUSTODY SEALS

When samples are shipped to the laboratory, they must be placed in containers sealed with custody seals. A typical custody seal is shown in **Figure 1**. Some custody seals are serially numbered. Other custody seals are unnumbered seals or evidence tape.

Two seals must be placed on each shipping container (cooler), one at the front and one at the back as shown in **Figure 1**. Clear tape should be placed over seals to ensure that seals are not accidentally broken during shipment.

5.0 RELATED REFERENCES

HF-FORM-001 - Chain-of-Custody Record (3-part NCR form)

 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY OFFICIAL SAMPLE SEAL	SAMPLE NO.	DATE
	SIGNATURE	
	PRINT NAME AND TITLE (<i>Inspector, Analyst or Technician</i>)	
	SEAL BROKEN BY	DATE
EPA FORM 7500-2 (R7-75)		

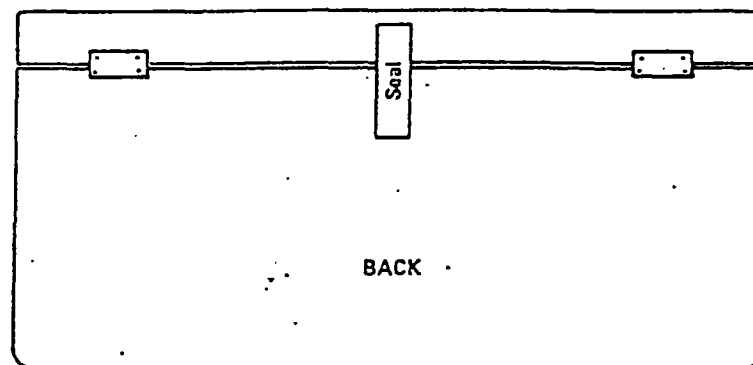
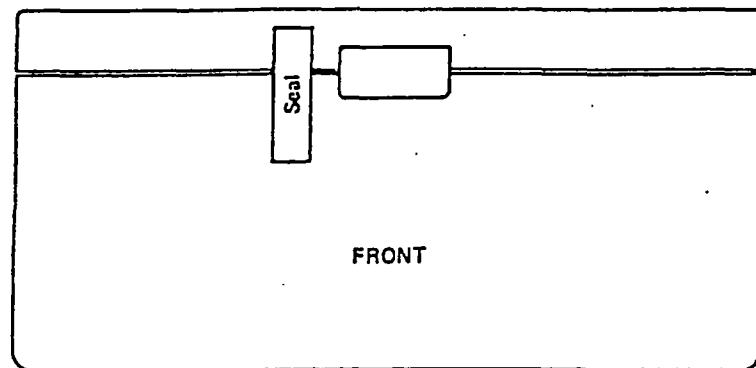


Figure 1. Proper Placement of Custody Seals

3020 Bozeman Avenue - Helena, Montana 59601 - (406)443-4150

[illegible]

STANDARD OPERATING PROCEDURE
DECONTAMINATION OF SAMPLING EQUIPMENT
HF-SOP-7

1.0 PURPOSE

Unless entirely disposable sampling equipment is used, cross-contamination can occur and sampling equipment must be decontaminated between sampling locations. The following are examples of equipment that may require decontamination:

1. Water level probe;
2. Reusable bailers used to obtain samples from wells;
3. Containers used to composite or contain samples;
4. Soil piston sampler;
5. Water filter apparatus (0.45 micron);
6. Soil coring devices; and
7. Drilling rig and/or backhoe.

This list is not exhaustive and field personnel should review sampling plans prior to implementation, and plan decontamination procedures in accordance with the type of work to be conducted and the equipment to be used.

2.0 EQUIPMENT

One or more of the items below is required. Check procedures that follow.

Tap water	Gloves (latex or nitrile)	
Non-phosphate detergent	Distilled or Deionized (DI) Water	Buckets
High Pressure Washer	Organic solvent (preferably hexane or methanol), certified ACS Grade or better	Brushes

3.0 PROCEDURES

Effective decontamination of sampling equipment for sampling inorganics can be achieved by using the following three step process:

1. Wash equipment in warm water and detergent, scrubbing with brushes as necessary to remove visible contaminants;
2. Rinse equipment thoroughly with clean tap water; and

3. Rinse equipment thoroughly with DI (deionized) water.

When sampling for various organic parameters which leave heavy residues on sampling equipment, decontamination may require additional steps:

4. Solvent rinse (preferably hexane or methanol, certified ACS Grade or better); and
5. DI water rinse.

Deionized or distilled water used during sampling equipment decontamination should be obtained from a source with documented capability to produce contaminant-free water. The source of DI water used (both production source and individual carboy) and any available measurements such as specific conductivity should be recorded in the field notebook. At least 50 mL of DI water should be run through the DI carboy spout prior to using DI water for decontamination or blank sample purposes.

Specific decontamination procedures used should be recorded in field notebooks. Special procedures (i.e., dilute acid rinses, alternate solvent rinses) may be required for some projects. Any departures from the basic protocol given above for inorganics or organics should also be noted.

The subsections below suggest specific procedures relevant to equipment which may require frequent decontamination.

3.1 WATER LEVEL PROBES

The water level probe should generally be decontaminated between measurements by rinsing thoroughly with DI or distilled water. If groundwater is known to be contaminated with inorganic or organic constituents, however, additional rinses with soap and water or organic solvent may be required.

3.2 BAILERS

Reusable bailers normally will be stainless steel, teflon or PVC plastic (**NOTE: PVC is not to be used when organics are of concern**). A bailer can be used exclusively on one monitoring well (dedicated bailer) or used at multiple wells.

If dedicated bailers are used, they will be rinsed with tap water, then rinsed with DI water. The bailers then will be stored in capped PVC containers in Hydrometrics' storage area.

Bailers that are used in more than one well will be decontaminated by rinsing between wells. All bailers will be rinsed a minimum of three times with the water to be sampled before the sample is taken.

Disposable polypropylene twine will be used for bailing with new twine used for each well.

3.3 CONTAINERS

Containers may be used to composite or hold water or soil samples. Between samples, these containers must be decontaminated. Water sample containers also should be rinsed a minimum of three times with water to be sampled.

3.4 SOIL PISTON SAMPLER

The soil piston sampler will be decontaminated between sample sites by washing in warm water and detergent followed by rinses in tap water and DI water.

3.5 WATER FILTER

Most filtered water samples are processed through disposable cartridge filters using a peristaltic pump and disposable silicone tubing. However, if a reusable pressure water filter apparatus is used to filter water samples through flat 0.45 micron membranes, the filter apparatus must be decontaminated after each use with soap and water, tap water, and DI water as necessary. The filter apparatus should then be rinsed three times with the water to be sampled prior to taking the sample. Additionally, a volume of sample water is flushed through the new filter before the actual sample is taken (see **HF-SOP-73, Filtration of Water Samples**).

3.6 SOIL CORING DEVICES

Soil samples may be obtained from drill holes by use of coring devices. Split spoons or Shelby tubes can be used. These devices will be decontaminated by thoroughly washing between each sampling depth and sampling sites. Washing will include warm water and detergent followed by a rinse with tap water and DI water.

3.7 DRILLING RIG

Cross-contamination may occur from the drilling rig. The drilling rods and drilling bits will be washed with tap water between holes and, if necessary, they will be washed with warm water and detergent to remove all dirt or other potentially contaminated material.

If necessary, a pressurized washer (hot or cold water as appropriate) should be used. The detergent wash should be followed by a tap water rinse. This procedure is applicable for both **ORGANIC** and **INORGANIC** samples.

3.8 BACKHOE

Cross-contamination may occur from the backhoe. Therefore, the bucket and boom shall be washed with a pressurized washer capable of producing at least 1500 psi at a temperature of

120°F. The backhoe shall be washed with detergent water and then rinsed with municipal tap water. This procedure is applicable for both **ORGANIC** and **INORGANIC** samples.

4.0 RINSATE BLANK COLLECTION

Equipment used in collection of water samples often requires testing to assure that decontamination procedures are effective. This will be accomplished by rinsing of the decontaminated equipment with deionized water and measurement of the concentration of parameters of interest in this "blank sample". Sufficient blanks will be collected to ensure there is no cross-contamination caused by the sampling device. Details of rinsate blank collection procedures are contained in **HS-SOP-13, Rinsate Blank Collection**. Typically, blank collection and analysis procedures are also specified in the project work plan.

5.0 ASSOCIATED REFERENCES

HF-SOP-73 Filtration of Water Samples

HS-SOP-13 Rinsate Blank Collection

STANDARD OPERATING PROCEDURE

LABELING AND DOCUMENTATION OF SAMPLES HF-SOP-29

1.0 PURPOSE

Documentation of all samples is an important aspect of the project quality assurance program. This SOP specifically describes sample labeling procedure, but also addresses related aspects of sample documentation, all or some of which may be required by the project Quality Assurance Project Plan (QAPP).

2.0 EQUIPMENT

Sample documentation will involve use of some or all of the following:

1. Sample Identification Tag or Labels;
2. Chain-of-Custody Records;
3. Custody Seals;
4. Sample Analysis Form, or cover letter and parameter list; and
5. Field Notebooks.

These documents are sequentially numbered or sequentially paged.

All forms are completed using waterproof ink. Where necessary, the sample labels are protected with label protection tape.

3.0 SAMPLE IDENTIFICATION TAGS OR LABELS

Projects which may be the subject of litigation or are mandated by the EPA typically require serially numbered Sample Identification Tags. Sample labels (generally self-adhesive) are used in lieu of Sample Identification Tags for many projects and provide the same information, but are not serially numbered. The following discussion pertains specifically to use of Sample Identification Tags but, except for the next two paragraphs, is applicable to sample labeling in general.

Sample Identification Tags are distributed to field investigators and the serial numbers are recorded in project files and the field notebook. Individuals are accountable for each tag assigned to them. A tag is considered in their possession until it has been filled out, attached to

a sample and transferred to another individual with the corresponding Chain-of-Custody Record.

At no time are any Sample Identification Tags to be discarded. If any tags are lost, voided or damaged, the circumstances are noted in the appropriate field notebook immediately upon discovery and the Quality Assurance officer notified. At the completion of the field investigation activities, all unused Sample Identification Tags are returned and are checked against the list of assigned serial numbers.

Samples are removed from the sample location and transferred to a laboratory or other location for analysis. Before removal, however, a sample is often separated into fractions depending on the analysis to be performed. Each portion is preserved in accordance with prescribed procedures and each is identified with a separate Sample Identification Tag. In this case, each tag should indicate in the "Remarks" section that it is a split sample.

The information recorded on the tag or label includes:

- **Project Code.** An assigned Hydrometrics number (optional);
- **Station Number.** A code assigned by the Field Team Leader (optional), which identifies the station location;
- **Date.** A six-digit number indicating the year, month and day of collection;
- **Time.** A four-digit number indicating the 24-hour clock time of collection (for example, 1345 for 1:45 p.m.);
- **Sample Number.** The sample code number assigned to that sample and recorded in the field notebook;
- **Samplers.** Each sampler's name;
- **Preservative.** The tag should indicate whether a preservative is used, the type of preservative, and whether the sample has been field filtered;
- **Analysis.** The general type of analysis requested;
- **Tag Number.** A unique serial number, stamped on each tag (optional); and
- **Remarks.** The sampler's record of pertinent information (sample matrix, dissolved vs. total, highly contaminated, etc.).

The tag used for water, soil, and sediment samples contain an appropriate place for designating the sample as a grab or a composite, identifying the type of sample collected for analysis, and

indicating preservation, if any. The Sample Identification Tags are attached to or folded around each sample and are taped in place.

After collection, separation, identification and preservation, the sample is handled using chain-of-custody procedures as discussed in the **Chain-of-Custody Standard Operating Procedure (HF-SOP-5)**.

If the composite or grab sample is to be split, aliquoted portions are placed into similar sample containers. Sample Identification Tags are completed and attached to each container. Tags on quality control samples (e.g. blank, duplicate, blind field standards) are NOT marked to identify samples as such.

3.1 SAMPLE CODE NUMBERING OF DUPLICATE SAMPLES FOR XRF ANALYSES

When collecting duplicate soil samples to be analyzed by XRF techniques, the duplicate sample number is the same as the original sample number with the exception of a suffix "D" designation.

For example:	XYZ-9710-100	Original Sample Number
	XYZ-9710-100D	Duplicate Sample Number

4.0 CHAIN-OF-CUSTODY

Samples collected during any investigation may be used as evidence and their possession must be traceable from the time the samples are collected until they are introduced as evidence in legal proceedings. To document sample possession, Chain-of-Custody procedures are followed. These procedures are described in the **Chain-of-Custody Standard Operating Procedure (HF-SOP-5)**.

5.0 SAMPLE SHIPMENT

Samples are packaged properly for shipment as described in the **Packing and Shipping Samples Standard Operating Procedure (HF-SOP-4)** and dispatched to the appropriate laboratory for analysis.

If sent by mail, the package is registered with return receipt requested. If sent by overnight express courier or common carrier, a Bill of Lading is used. Air freight shipments are sent collect. Freight bills, Postal Service receipts and Bills of Lading are retained as part of the permanent documentation.

When Chain-of-Custody is required, a separate custody record must accompany each shipment. When transferring samples, the individuals relinquishing and receiving samples will sign, date

and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst at the laboratory.

6.0 SAMPLE ANALYSIS REQUEST

Samples sent to a laboratory for testing will be accompanied by a Request for Analytical Services or cover letter that describe the samples, specifies the testing required, and who is to receive the analytical report. Commonly, a standard analytical schedule is used for a project and this schedule should be attached to the Request for Analytical Services or cover letter.

7.0 FIELD NOTEBOOKS

A bound field notebook must be maintained by the Field Team Leader to provide a daily record of significant events, observations and measurements during field investigations. All entries should be signed and dated. All members of the field investigation should use this notebook. It should be kept as a permanent record.

These notebooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the project and to refresh the memory of the field personnel if called upon to give testimony during legal proceedings. In a legal proceeding, notes, if referred to, are subject to cross-examination and are admissible as evidence.

8.0 CORRECTIONS TO DOCUMENTATION

Unless prohibited by weather conditions, all original data should be recorded in field notebooks, Sample Identification Tags and Chain-of-Custody Records are written with waterproof ink. None of these accountable serialized documents are to be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on an accountable document assigned to one individual, that individual may make corrections simply by crossing a single line through the error and entering the correct information. The erroneous information should not be obliterated. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All subsequent corrections must be initialed and dated.

9.0 SAMPLE NUMBERING

All samples of water and earth materials will be assigned a number by Hydrometrics. The numbers assigned for water samples will all use the project prefix and will be followed by a sequential number. The first sequential number will be 1 and a total of 5000 numbers are available for project water samples. A water sample may consist of several bottles if the sample is to be analyzed for several parameters, each requiring a different preservation technique. All

bottles for a sample will have the same sample number. Sampling data including site identification and sample numbers will be recorded in the field sampler's notebook to allow positive identification of the sample.

All samples of earth materials such as drilling cores from test wells and stream bottom sediment will be assigned a number by Hydrometrics. The numbers assigned for earth material samples will use the project prefix and will be followed by a sequential number. The first sequential number will be 5001 and a total of 4999 numbers are available for these samples. Sampling data and sample numbers for earth materials will be recorded and handled in the same manner as for water samples.

The laboratory will not be aware of the specific sample source. All quality control samples will use the same sample numbering method.

10.0 ASSOCIATED REFERENCES

National Water Well Association, 1986. RCRA Groundwater Monitoring Technical Enforcement Document. September.

U.S. EPA, 1986. Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, Vol. II: Field Manual Physical/Chemical Methods. November.

STANDARD OPERATING PROCEDURE

FIELD NOTEBOOKS HF-SOP-31

1.0 PURPOSE

Field notebooks are intended to provide sufficient data and observations to enable project participants to reconstruct events that occurred during the project and to refresh the memories of field personnel if called upon to give testimony during legal proceedings. In a legal proceeding, notes, if referred to, are subject to cross-examination and are admissible as evidence.

2.0 EQUIPMENT

Bound notebook with water resistant pages

Pen with indelible ink

3.0 PROCEDURE

A bound field notebook must be maintained by the Field Team Leader to provide a daily record of significant events, observations and measurements during field investigations. All members of the field investigation should use this notebook and initial their entries. It should be kept as a permanent record. All information called for in the Work Plan must be recorded, and any other data pertinent to the investigation at hand.

General information recorded in the field notebooks must include:

- Date and time;
- Weather conditions;
- Site name and description (if the first visit);
- Names of individuals participating in and/or observing sampling; and
- Unusual circumstances (unlocked well lid, missing staff gage, flood stage, etc.).

In addition, sampling personnel must record descriptions of sampling activities and parameters determined at each sampling station, appropriate to the type of media being sampled. This should include (but is not limited to) the following:

1) For water sampling (surface water and/or groundwater):

Water level measurement

Flow measurement

Sample collection:

Site number

Sample code number

Date and time

Bottle size(s)

Sample tag number (for Superfund investigations)

Bottle quality control number (for Superfund)

Dissolved Oxygen

Water Temperature

Specific conductivity

Calibration of Field Equipment

Preservative(s)

pH

Filtration

2) For soil sampling and/or sediment sampling:

Soil moisture conditions

Soil type (textural classification)

Sample collection

Site number

Sample code number

Date and time

Sample tag number (for Superfund investigations)

Sketch map of property, designated sample units and sample locations (for soil samples), or cross-section of stream sampled and approximate grab sample locations (for sediment samples).

Site descriptions should be adequate for someone unfamiliar with the site to relocate sampling point, and should be particularly detailed if this is the first sampling.

Other information deemed pertinent to sampling procedures and field conditions should be entered in field notebooks. This should include (at a minimum):

1. Notes confirming that calibration of field instruments (pH, SC, DO, etc.) was performed prior to sampling;
2. Notes detailing decontamination procedures performed (methods, any reagents used);
3. Notes describing the source of DI water used for decontamination or for collection of blanks; and
4. Notes describing shipment of samples to the laboratory and any enclosures included as part of such shipments (chain-of-custody, parameter lists, etc.).

All field notes should be entered into bound notebooks with indelible ink. Corrections should be made by deleting incorrect information with a single line and initialing the deletion in the field notebook. Each page should be numbered consecutively and signed by field personnel. All field records should be kept under custody of the Field Team Leader. Copies of the field records should be available for distribution to all team members for data reduction and report preparation.

STANDARD OPERATING PROCEDURE
MANAGEMENT AND VALIDATION
OF FIELD AND LABORATORY DATA[®]
HF-SOP-58

1.0 INTRODUCTION

This is a summary of procedures for data quality control at Hydrometrics. This plan contains the standard routines that have been established for management and validation of all field and laboratory data. The purpose of this plan is to:

- Summarize procedures used in the collection, input, and validation of data;
- Establish personnel responsibilities for each step in the process; and
- Describe documentation of this process and use of standard forms.

This process has been developed by Hydrometrics' Data Quality Department and deviations from this process must be approved by this department.

2.0 PROJECT SAMPLING, ANALYTICAL, AND QUALITY ASSURANCE PLANS

Collection of good quality data begins with good sampling and analytical plans (SAPs) and quality assurance program plans (QAPPs). Data does not become better with use, with validation, or with graphical presentation. Therefore, the greatest burden of responsibility for the quality of data is on the manager of each project and prior to sample collection and analysis. Preparers of SAPs and QAPPs are encouraged to seek assistance in preparation of SAPs and QAPPs from Data Quality Department personnel. They can advise you as to quality criteria and avoid inconsistencies in specifications that can make data validation troublesome, unnecessarily time consuming, and possibly meaningless. Copies of all SAPs and QAPPs must be submitted to the **Data Quality Department** to aid in the validation of data. Many potentially severe problems in data handling can be avoided by coordination with **Data Quality Department** personnel.

3.0 DATA FLOW AND DOCUMENTATION

Data flow in the management and validation process is summarized as follows:

1) Initiate Sampling Event

Project Manager or Field Supervisor initiates sampling events by submitting a Monitoring Description Form (**HF-FORM-449**) to the **Data Quality Department**.

The purpose of this form is to provide:

- A list of sites to be monitored (site code list) including information on any new sites;
- A description of the types and numbers of quality control samples to be submitted; and
- The analytical schedule (parameter list) for field and laboratory analyses.

These forms are kept on file in the **Data Quality Department's** sample event files (SEF) for ready reference.

2) Generate Sample Code List and Start Sampling Event File

Sample codes are needed for all sites where data is to be collected regardless of whether a water quality sample is collected (e.g., a surface water site where only flow is measured). The **Data Quality Department** will generate a sample code list which lists sample codes, site codes, and site descriptions for all planned monitoring sites. A set of extra sample code numbers to be used for additional unplanned samples or field data also will be developed. At this time, the **Data Quality Department** will also start a Sampling Event File in which all information and forms regarding the monitoring event will be filed.

3) Collect and Record Monitoring Data

All pertinent field data will be recorded on sampling forms. Data is originally recorded in a field notebook and data will be transcribed onto the sampling forms (**Identification and Description of Field Sampling Sites – HF-FORM-407**) by field technicians. Sampling forms must be filled out completely. If data is not collected, an explanation must be given (e.g., stream was dry, staff gage is missing, Township and Range not known, etc.).

4) Shipment of Samples

All samples submitted to labs must be accompanied with:

- Chain-of-custody documentation (**HF-FORM-1**);
- Analytical parameter list; and
- Letter of transmittal to the laboratory.

ALL labs for **ALL** projects will receive a work plan (even in memo or letter form); or a QAPP.

An example transmittal letter is attached. **Transmittal letters must specify that analytical results are to be sent to the Data Quality Department.**

5) **Submit Field Data and Completed Sampling Forms**

Upon returning from the field, the **Field Technician** will submit a Data Quality Completion Form (**HF-FORM-450**) with the following data and forms to the **Data Quality Department**:

- Sample code list (revised to include any deviations from scheduled monitoring);
- Copy of field notes;
- Field forms;
- Copy of chain-of-custody documentation;
- Analytical parameter list;
- Copy of true values of standards and/or spikes used for QC purposes; and
- Letter of transmittal to the laboratory.

Information on new monitoring sites (name of site, site code, and type of site) must be approved by the **Project Manager** prior to input into the database system and any new sites must be described on the Monitoring Description Form (**HF-FORM-449**).

Samplers will give copies of **all** field data, including field notebooks, flow forms, sampling forms, and sample code lists, to the **Data Quality Department** for entry into the database. All computer-calculated flows will be performed by the **Data Quality Department**. To provide an additional check on the accuracy of computer-calculated streamflows, field technicians should also calculate flow data.

6) **Input and Validation of Laboratory Data**

The **Data Quality Department** will receive **all** laboratory data. When lab data has returned to Hydrometrics, the Project Manager will be notified by the department.

Laboratory data will be input and visually validated within a one week period. A memo explaining the findings of the validation, recommendations for laboratory retests, and an attached copy of the computer printout of the analysis will be given to the **Project Manager** or his designated representative. If laboratory retests or further validation are required, the **Project Manager** must request them from the **Data Quality Department**.

Please, do not contact laboratories directly! The Data Quality Department tracks data and retests from the labs. If you have a question about the status of data, ask Data Quality personnel to investigate for you.

7) **Field Technician Debriefing and Data Review**

The **Project Manager** and **Field Technician** should meet to discuss the monitoring results, performance on field quality control, the adequacy of the data, and any possible changes for future monitoring.

8) **Closing and Storage of Sampling Event File**

Upon receipt of all relevant documentation and approval of data validation by the **Project Manager** and **Field Technician**, the sampling event file will be labeled as "validated" and stored in the **Data Quality Department's** filing system.

9) **Summary Memo to Client and Administration File**

It is recommended, although not required, that the **Project Manager** provide the client with a memo summarizing results of the monitoring event. The memo should include:

- A description of the monitoring conducted;
- A draft copy of the validated data;
- A description of any anomalous data and laboratory retest results; and
- Any suggested changes for future monitoring.

The purposes of this memo are to keep the client updated on monitoring results and to notify the client contact concerning any important information about the sampling event. Therefore, summary memos should be customized for each client and also could include additional items such as hydrographs, photographs, graphs of water quality parameters vs time, etc. Copies of summary memos should be submitted to the sampling event file.

4.0 ELEMENTS OF DATA QUALITY PLAN

1) Monitoring Description Form (HF-FORM-449)

This form is to be used by the **Project Manager** or **Field Supervisor** to initiate a sampling event. The form provides information regarding what sites are to be sampled, what samples are to be collected and analyzed, and other information regarding the sampling event.

2) Data Quality Completion Form (HF-FORM-450)

This form is to be completed by the person requesting work to be done. It will be attached to the sampling information when it is submitted by field personnel. It will then remain in the sample event file so the progress of a sampling event can be quickly checked. The Data Quality Completion Form should be initialed immediately upon the completion of each step.

3) Sample Code List

The sample code list is a list assigned by the **Data Quality Department** before a sampling event. This list contains a sample number for each site which is to be sampled or observed. There will also be a description of each site.

4) Site Codes

Site codes will designate an actual physical location only. Matrix type will be specified in the sample number. For example, all samples collected from Monitoring Well number 1 (MW-1) will have MW-1 as their site code, whether they are soil samples, water samples, or other types of samples. When soil samples are taken from multiple depth intervals at the same site, each will be given an integer suffix which corresponds to the depth interval.

This will simplify identification of site names on maps and facilitate comparison of all types of sampling at a given site. Assignment of site codes to sampling sites is the responsibility of the **Project Manager**. This information must be provided to the **Data Quality Department**.

5) Sampling Event File

Laboratory and field data will be filed by sampling event. The **Data Quality Department** will begin a sampling event file for each new sample code list they generate. Each file will contain the following:

- Copy of the completed sample code list;
- Data quality completion form;
- Chain-of-custody forms;
- Letter of transmittal to the lab;
- Validation checklist;
- Any memos regarding the sampling event;
- All field notes and field data;
- Laboratory results; and
- Retest results.

All client files should have an information file set up which will contain the following:

- A copy of the original Work Plan and any revised Work Plans;
- Site maps with a list of site descriptions; and
- Special instructions for working with the data and any pertinent information that may apply to the data.

It is the responsibility of the **Project Manager** to make sure a copy of the three items above are received by the **Data Quality Department** as soon as they are made available.

All sample event files are in bright yellow jackets. Information files are in purple jackets, the validation file is teal and red files signify data that is for in-house use only and has not been input to the database. All files are stored in the file cabinets in the **Data Quality Department**.

6) Special Data Files

Data which is not typically entered into the water quality database will continue to be filed in the Project Files (main file cabinets). Special data includes pump testing data, infiltration data, survey data, etc. Each **Project Manager** is responsible for maintaining special data files as needed for individual projects.

The exception to this is a special sampling event that may be pertinent but the **Project Manager** has indicated the data should not be entered into the database. This data is stored in a red jacket file in the computer files. However, the practice of maintaining "special" files is discouraged. Because the data is not entered, it is not possible to conduct the normal validation steps and bad data may not be discovered in time to be retested (sample holding times are 6 months or less). Because the data does not show up in the database, experience has shown that the data will eventually become effectively lost or forgotten. Therefore, if data must be withheld from the database, it will be necessary for the Project Manager to provide a brief memo describing the data.

7) Data Validation Options and Checklists

There are three levels of data validation available:

Visual Validation: (HF-FORM-452)

This means data (lab and field) is checked for correctness of parameters, dates, site codes, site types, measurement basis, and units of measurement. Data values are compared with previous data for the site. Data will be printed out and returned to the **Project Manager** with a report indicating that a visual validation has been done and if anything out of the ordinary was found. This level is done for all projects.

Standard Validation: (HF-FORM-453)

All of the above visual validation is done plus the following: ion balance and statistical analysis are run, a check for completeness of field procedures, a check of quality control of field procedures, and data is flagged for exceedance of quality control limits. Data will be printed out and returned to the **Project Manager** with a validation report indicating acceptability of data.

EPA Validation: (HF-FORM-454)

This level of validation is time consuming and expensive and is typically only done for Superfund or RCRA projects. This validation includes the visual and standard validation procedures plus a check of frequency, precision, accuracy and completeness of all field and laboratory quality control procedures. The lab data is also flagged for exceedance in accordance with EPA Codes. Data will be printed out and returned to the **Project Manager** with a validation summary indicating acceptability of data per EPA Standards.

Validation procedures are documented through validation checklists. As each step in visual validation is done, the validation item is checked off and initialed. The validation checklist is provided to the **Project Manager** with a printout of the sampling results and a memo indicating any data problems. A copy of the checklist and memo will be filed

in the sample session file. This same procedure is used for Standard and EPA validations as well but, instead of a memo, a more detailed report and statistical summaries will be provided.

5.0 INDIVIDUAL RESPONSIBILITIES

The following are responsibilities required from the different personnel involved in monitoring and data quality at Hydrometrics:

Project Managers

Keep **Data Quality Department** personnel informed of upcoming sampling events, new projects, type of validation needed (a visual will always be done), changes in existing projects (e.g. changes in detection limits etc.) and deadlines for reports that will need any information from the Data Quality staff. Provide Work Plans, QAPPs, SAPs, and information on monitoring new sites to the **Data Quality Department** as soon as available.

The **Project Manager** will determine which field personnel will be Field Supervisor if the **Project Manager** is not available to head up the project.

Fill out the "Data Quality Completion" Form (**HF-FORM-450**) for the generation of sample code numbers and information pertaining to sample collection. Return to the **Data Quality Department** as soon as possible (at least 5 days prior to sampling if possible).

Meet with the field technician, go over the request form and give sample code numbers to field technician before sampling session.

Field Technicians

Meet with the **Project Manager** or **Field Supervisor** to get information and sample code numbers prior to sampling event.

Fill out the "Data Quality Completion" form (**HF-FORM-450**), attach it to the sampling information and give it to the Data Quality Department within 5 days of returning to the office. Make sure to indicate on the cover letter to the lab or Chain-of-Custody that analysis is to be returned to the **Data Quality Department**.

Data Quality Department

When the lab analyses arrive at Hydrometrics, the project manager or other designated project staff will be notified that the data has been received by the **Data Quality Department**.

All data will be input and visually validated within a one week period (field and lab data arrive separately so each will receive a one week input time). The exceptions are large sampling packages and CLP packages which take a longer period of time.

- If more extensive validation is required, it will be done and a copy of the data set and a memo of the findings will be given to the project manager; and
- A file will be created and all data will be filed in the **Data Quality Departments'** filing system. The final data report will be attached to the "pink" signed validation report and filed in a teal jacket.

6.0 ASSOCIATED REFERENCES

HF-FORM-407 IDENTIFICATION AND DESCRIPTION OF
FIELD SAMPLING SITES

HF-FORM-449 MONITORING DESCRIPTION FORM

HF-FORM-450 DATA QUALITY COMPLETION FORM

HF-FORM-452 VISUAL VALIDATION CHECKLIST FORM

HF-FORM-453 STANDARD VALIDATION CHECKLIST FORM

HF-FORM-454 EPA VALIDATION CHECKLIST FORM

Laboratory Transmittal letter

STANDARD OPERATING PROCEDURE

PROCEDURE FOR COLLECTING SURFACE SOIL SAMPLES[®]

HS-SOP-6

1.0 PURPOSE

This SOP describes the procedure for collecting a surface soil sample from the top 1 to 2 inches for subsequent chemical analysis.

Soil types and soil characteristics can vary considerable within and between sampling sites. It is important, therefore, that detailed records be taken; particularly of the sampling location, depth, and soil characteristics such as grain size and color. While this SOP describes a general procedure for collection surface soil samples, because of soil heterogeneity issues, modifications to this procedure may be appropriate depending on site-specific conditions and data collection objectives. Therefore, the project specific sampling and analysis plan should be consulted for any deviations to the procedure described below.

2.0 EQUIPMENT

- Stainless steel spoon or plastic spoon;
- Wide mouth glass jar (organics);
- 1 gallon size Zip-lock plastic bags (metals);
- Surgical gloves;
- Measuring tape; and
- Field notebook.

When sampling for metals, a stainless steel or plastic spoon should be used for collecting the sample. Sampling tools which are plated with chrome or other materials are to be avoided.

3.0 PROCEDURE

1. Locate the site to be sampled and record the site name and location in the field notebook (**HF-SOP-31**). The notes and drawings should outline the property boundary, location of sample units and sample sites, sample site names, sample depths and sample numbers, as appropriate.
2. An approximate 1x1 foot area should be delineated with the sample collected from the top 1 to 2 inches of soil within this area. A stainless steel or plastic spoon should be used to collect the sample. Generally, between 100 and 500

grams of soil is required. If more sample is required the sampling area should be expanded without increasing the depth of sampling.

3. If a sod layer is present, sod should be removed or folded back prior to sampling. Sod should not be included on the surface soil sample unless specifically required by the work plan. In this case, refer to HS-SOP-12, Procedure for Sampling Sod.
4. For grab samples, soil collected using a stainless steel or plastic spoon (at the surface or at depth) should be placed directly into the sample container. For metals samples a plastic zip-lock bag is an appropriate container. For organic samples, a glass container is required unless otherwise specified. Generally, coarse material should be excluded from the sample (greater than approximately 1/4 inch where feasible).
5. For composite samples or field split samples, the soil grab sample should be transferred from the stainless steel or plastic spoon to a stainless steel mixing bowl, Teflon tray, or similar device free of potential sample contaminants. Once all grab samples are collected, the sample should be thoroughly mixed prior to transferring the sample to the sample container. Note that samples for volatile organic constituents should not be mixed to minimize potential losses to the atmosphere. Alternately, composite samples may be obtained by transferring each grab sample directly to the plastic sample bag, provided there is sufficient room in the sample to ensure thorough mixing of the sample within the bag. (Since the laboratory may only use a small portion of the total sample, it is important that the sample be thoroughly mixed so that the analysis is representative of all sample grab locations.)
6. Sample containers should be labeled, at a minimum, with sample date and sample number to permit cross referencing with the field notebook. If the sample is not to be submitted as a completely blind sample, other information may also be appropriate including sample depth, station identification, soil type. Refer to **HF-SOP-29**, Labeling and Documentation of Samples.
7. Refer to **HF-SOP-5**, Chain-of-Custody, and **HF-SOP-4**, Packing and Shipping Samples for sample handling procedures.
8. All equipment which contact the soil should be decontaminated after collecting the sample. Refer to **HF-SOP-7**, Decontamination of Sampling Equipment.

4.0 ASSOCIATED REFERENCES

HF-SOP-31 FIELD NOTEBOOKS

HF-SOP-29 LABELING AND DOCUMENTATION OF SAMPLES

HF-SOP-5 CHAIN-OF-CUSTODY

HF-SOP-4 PACKING AND SHIPPING SAMPLES

HF-SOP-7 DECONTAMINATION OF SAMPLING EQUIPMENT

STANDARD OPERATING PROCEDURE

RINSATE BLANK COLLECTION®

HS-SOP-13

1.0 PURPOSE

The purpose of this procedure is to collect Quality Control blanks that can be used to assess the potential for sample cross-contamination.

2.0 EQUIPMENT

Sampling equipment to be tested
Field Notebook
Carboy with deionized water
Plastic catch basin

Surgical gloves
Sample bottles
Chain-of-Custody documentation

3.0 PROCEDURE

Collection and analysis of rinsate (equipment) blanks is intended to provide information on the contamination and cross-contamination potential introduced by sampling equipment and methods. Any surfaces which contact samples may contribute analytes of interest to the sample, thereby creating the possibility of positive bias in analytical results. Decontamination procedures (see **HF-SOP-7**) have been designed to minimize the likelihood of sample contamination. The effectiveness of decontamination of sampling equipment is monitored by rinsing equipment with deionized water, and measuring the concentration of parameters of interest in the resulting "blank" sample.

In general, any equipment used to collect, composite, or store samples that directly contacts the sample should be subjected to the rinsate blank procedure. Examples include pumps, filters, bailers, bottles, coring devices, shovels, trowels, and large containers used for compositing a number of samples. Other items may also require decontamination and testing through collection of rinsate blanks. The following steps describe basic rinsate blank collection procedures. Specific methods used should be documented in field notebooks whenever rinsate blanks are collected.

1. Obtain sample equipment and be sure it has been decontaminated using appropriate procedures in **HF-SOP-7** (Decontamination of Sampling Equipment).

2. Run about 50 mLs of water through carboy spigot to clean it out before collecting blank sample.
3. Place the equipment under the carboy spigot and inside the catch basin. The catch basin can be made by cutting the top off a sample bottle.
4. With surgical gloves on, open the spigot and run water over and/or through the sampling equipment. The water should contact the area of the equipment that is likely to contact the material to be sampled. Use only enough DI water to completely rinse the equipment surface. Excessive volumes of rinse water can dilute chemical concentrations in the rinsate blank, with a resulting loss of information.
5. Obtain enough water in the catch basin for the desired analysis.
6. Carefully pour water from the catch basin into the appropriate sample container for the parameters of interest, and add any necessary preservatives.
7. Document rinsate procedures in field notebooks, including a list of equipment rinsed, volumes of deionized water used, and the source of the deionized water.

STANDARD OPERATING PROCEDURE

SOIL SAMPLING PROCEDURE FOR TEST PITS HS-SOP-57

1.0 PURPOSE

This procedure describes the technique for collecting soil samples from test pits excavated with a backhoe.

2.0 EQUIPMENT

- Stainless steel trowel;
- Ziplock plastic bags (inorganic samples) or glass jars with teflon covers (organic samples);
- Surgical gloves; and
- Ladder.

3.0 PROCEDURE

1. Locate site on map, record site description (**Identification and Description of Field Sampling Sites - HF-SOP-2** and use form **HF-FORM-407**).
2. Direct the backhoe operator to excavate the pit. For pits deeper than 5 feet, one pit face will be sloped in accordance with OSHA requirements.
3. Using the stainless steel trowel, collect samples at depths specified in project work plan. First scrape area of pit wall to be sampled, discarding these first scrapings, then scrape again to peel off sample of uniform thickness throughout depth to be sampled. Be sure to clean trowel between depths sampled.
4. For grab samples, soil collected using a stainless steel or plastic spoon (at the surface or at depth) should be placed directly into the sample container. For metals samples a plastic zip-lock bag is an appropriate container. For organic samples, a glass container is required unless otherwise specified. Generally, coarse material should be excluded from the sample (greater than approximately 1/4 inch where feasible).
5. For composite samples or field split samples, the soil grab sample should be transferred from the stainless steel or plastic spoon to a stainless steel mixing bowl, Teflon tray, or similar device free of potential sample contaminants. Once all grab samples are collected, the sample should be thoroughly mixed prior to transferring the sample to the sample container. Note that samples for volatile organic constituents should not be mixed to minimize potential losses to the atmosphere. Alternately, composite samples may be obtained by transferring each

grab sample directly to the plastic sample bag, provided there is sufficient room in the sample to ensure thorough mixing of the sample within the bag. (Since the laboratory may only use a small portion of the total sample, it is important that the sample be thoroughly mixed so that the analysis is representative of all sample grab locations.)

6. Record date and time, depth of samples, soil description, etc. on HF-FORM-703 (Test Pit Field Form). A blank form is attached.
7. Direct backhoe operator to backfill pit.
8. Decontaminate trowel and backhoe bucket in accordance with between sample sites, in accordance with HF-SOP-7 (Decontamination of Sampling Equipment).

STANDARD OPERATING PROCEDURE
FIELD TEST PIT LOG COVER FORM©
(HF-FORM-703)

HYDROMETRICS, INC.®

Test Pit Name: _____

Field Log Cover Form

Project Information

Name _____
Client _____
Property Owner _____
Project Number _____

Point Identifying Information

Point ID _____
County _____
State _____
Legal Desc. _____
Desc. Location _____
Samp. # Prefix _____
Hole Depth _____
Elevation (GS) _____
Elevation (MP) _____
Northing _____
Easting _____

Excavation Information

Date Started _____
Date Finished _____
Recorded By _____
Equipment Owner _____
Equipment Operator _____
Excavation Method _____
Excavation Dimensions (L x W x D) _____

Measuring Information

Datum _____
Static Water Level _____
Static Water Date _____
MP Description _____
MP Height _____

Signature _____

**STANDARD OPERATING PROCEDURE
TEST PIT FIELD FORM: GRAPHICAL LOGS©
(HF-FORM-703)**

HYDROMETRICS, INC.®					Photos: <input type="checkbox"/> Y <input type="checkbox"/> N		Test Pit Name:				
Test Pit Field Form: Graphical Logs					Personnel:		Page of				
Sample Collection Log							Geological Log				
Depth	Length	Number	Date	Time	Sample Type	Notes	Top Depth	Bot. Depth	Hatching	Material Name	Unit Name
							Description				
							Description				
							Description				
							Description				

Graphical Description (optional)

**XRF ANALYTICAL TECHNIQUE,
XRF MANUFACTURER'S LITERATURE,
AND LABORATORY ANALYSIS PLAN**



Hydrometrics, Inc.®
consulting scientists, engineers, and contractors

5219 North Shirley
Suite 100
Ruston, WA 98407
(253) 752-1470
FAX (253) 752-7663
www.hydrometrics.com

September 14, 2000

Don Kaizen
City of Seattle
Seattle Public Utilities
Dexter Horton Building, 5th Floor
710 2nd Avenue
Seattle, WA 98104

Dear Mr. Kaizen:

Attached is information on analysis of lead and arsenic using XRF. As we discussed, Hydrometrics has successfully used this analytical technique in numerous soil investigation and cleanups throughout the U.S. This includes several extensive residential cleanup actions for lead and/or arsenic including Superfund sites in Ruston WA, Helena Montana, Denver Colorado, Beckemeyer Illinois and Murray Utah. The primary advantages of the technique are it is accurate, fast and cost effective. As we discussed, analytical turnaround is typically faster but as accurate as traditional wet chemistry methods. For this reason, cleanup contractors, as well as federal and state agency site managers have found this method ideal for site cleanup analytical requirements concerning soil lead and arsenic.

Attached are:

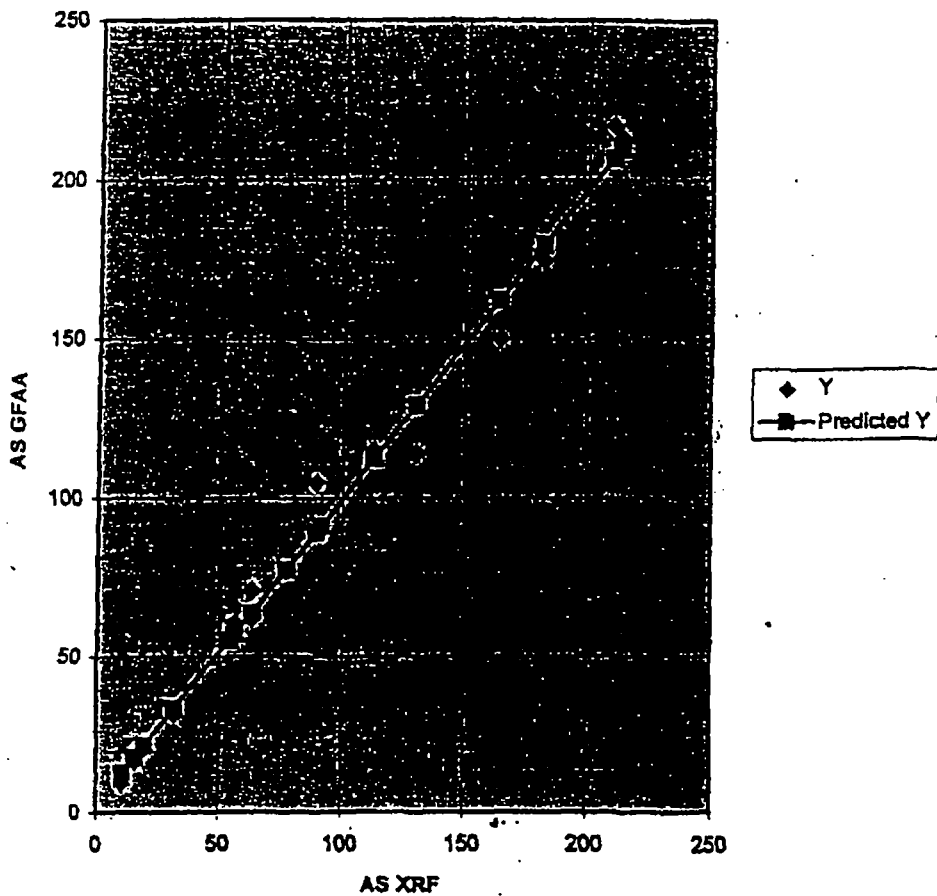
- Correlation curves comparing traditional wet chemistry results to XRF values. As the information shows, the correlation is very good with lead at about 99% and arsenic at about 98%.
- Literature from the XRF instrument manufacturer. As we discussed, Hydrometrics uses a Spectrace 5000 EDXRF, which is a laboratory grade instrument. This instrument has been used extensively for analysis at numerous projects similar to your residential cleanup and has proven reliable and accurate.

If you have any further questions or need more information, please call me.

Sincerely,

Robert J. Miller
Corporate Technical Manager

AS GFAA / AS XRF
CORRELATION CO. 0.987



	AS GFAA	PPM AS XRF
	55	65
	17	16
	21	20
	32	32
	77	77
	217	210
	61	56
	175	182
	150	164
	90	91
	62	63
	105	89
	114	130
	213	213
	115	113
	71	63
	9.8	11

SUMMARY OUTPUT

<u>Regression Statistics</u>	
Multiple R	0.993571
R Square	0.987183
Adjusted	0.986329
Standard	7.543539
Observati	17

ANOVA

	df	SS	MS	F	Significance F
Regression	1	65744.82	65744.82	1155.344	1.31E-15
Residual	15	853.5747	56.90498		
Total	16	66598.39			

	Coefficient	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0	Upper 95.0
Intercept	2.591723	3.233733	0.801465	0.435376	-4.30082	9.484267	-4.30082	9.484267
X Variable	0.97269	0.028617	33.99035	1.31E-15	0.911695	1.033685	0.911695	1.033685

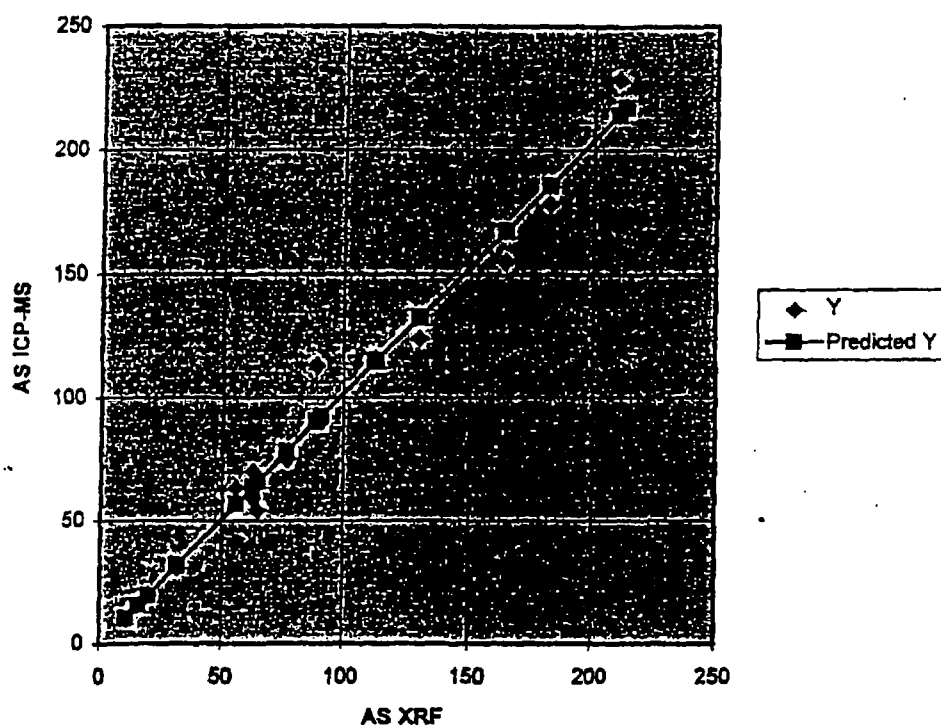
RESIDUAL OUTPUT

Observatio	redicted	Residuals	Standard Residuals
1	55.11697	-0.11697	-0.01551
2	18.15476	-1.15476	-0.15308
3	22.04552	-1.04552	-0.1386

PROBABILITY OUTPUT

Percentile	Y
2.941176	9.8
8.823529	17
14.70588	21

AS ICP-MS / AS XRF
CORRELATION CO. 0.983



	AS	PPM	AS
	ICP-MS		XRF
	54		65
	16		16
	20		20
	31		32
	75		77
	229		210
	63		56
	178		182
	155		164
	90		91
	59		63
	113		89
	124		130
	218		213
	116		113
	70		63
	9.9		11

SUMMARY OUTPUT

<u>Regression Statistics</u>	
Multiple R	0.991349
R Square	0.982773
Adjusted	0.981624
Standard	9.183537
Observati	17

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>ignificance F</i>
Regressio	1	72167.9	72167.9	855.7051	1.21E-14
Residual	15	1265.06	84.33735		
Total	16	73432.96			

	<i>Coefficient</i>	<i>andard Err</i>	<i>t Stat</i>	<i>P-value</i>	<i>ower 95%</i>	<i>pper 95%</i>	<i>ower 95.0</i>	<i>pper 95.0</i>
Intercept	-0.78706	3.970038	-0.19825	0.845511	-9.249	7.674879	-9.249	7.674879
X Variable	1.024627	0.035027	29.25244	1.21E-14	0.949969	1.099285	0.949969	1.099285

RESIDUAL OUTPUT

<i>bservatio</i>	<i>redicted</i>	<i>Residuals</i>	<i>dard Residuals</i>
1	65.81369	-11.8137	-1.2864

PROBABILITY OUTPUT

<i>Percentile</i>	<i>Y</i>
2.941176	9.9

PPM	
PB FAA	PB XRF
20	6 u
70	6 u
40	26
80	42
140	84
640	656
150	120
380	372
140	97
70	41
10	6 u
310	285
90	56
440	428
240	210
70	81
10	6 u

SUMMARY OUTPUT

u=Non detect

Regression Statistics

Multiple R	0.993845
R Square	0.987728
Adjusted	0.98691
Standard	20.2189
Observati	17

ANOVA

	df	SS	MS	F	Significance F
Regression	1	493562.1	493562.1	1207.332	9.46E-16
Residual	15	6132.058	408.8039		
Total	16	499694.1			

	Coefficient	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0	Upper 95.0
Intercept	29.78505	6.361465	4.682106	0.000295	16.2259	43.3442	16.2259	43.3442
X Variable	0.949109	0.027315	34.74669	9.46E-16	0.890889	1.00733	0.890889	1.00733

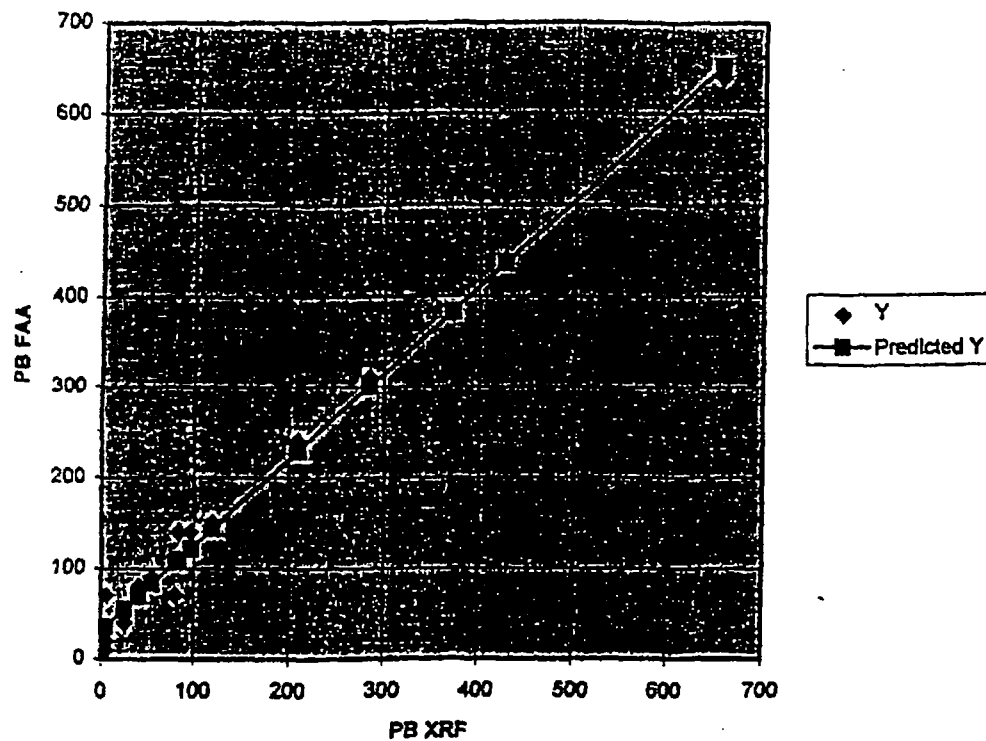
RESIDUAL OUTPUT

Observation	Predicted	Residuals	Standard Residuals
1	35.47971	-15.4797	-0.76561
2	35.47971	34.52029	1.707328

PROBABILITY OUTPUT

Percentile	Y
2.941176	10
8.823529	10

PB FAA / PB XRF
CORRELATION CO. 0.988



PPM	
PB ICP-MS	PB XRF
17	6u
40	6u
32	26
71	42
116	84
630	656
134	120
367	372
118	97
74	41
22	6u
294	285
86	56
426	428
229	210
93	81
5.8	6u

SUMMARY OUTPUT

u=Non detect

Regression Statistics	
Multiple R	0.998075
R Square	0.996154
Adjusted	0.995898
Standard	11.1036
Observati	17

ANOVA

	df	SS	MS	F	ignificance F
Regressio	1	479014.1	479014.1	3885.265	1.57E-19
Residual	15	1849.349	123.2899		
Total	16	480863.4			

	Coefficient	andard Err	t Stat	P-value	ower 95%	pper 95%	ower 95.0	pper 95.0
Intercept	23.33452	3.493522	6.679369	7.36E-06	15.88825	30.78079	15.88825	30.78079
X Variable	0.935017	0.015001	62.33189	1.57E-19	0.903044	0.96699	0.903044	0.96699

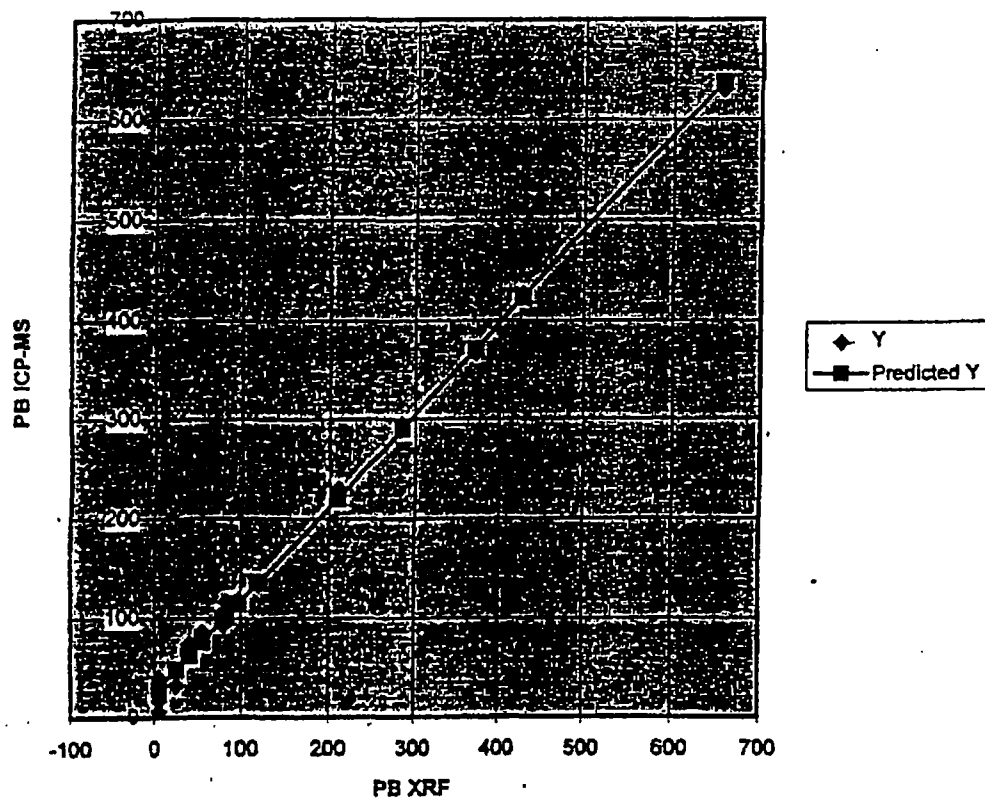
RESIDUAL OUTPUT

bservatio	redicted	Residuals	dard Residuals
1	28.94462	-11.9446	-1.07574

PROBABILITY OUTPUT

Percentile	Y
2.941176	5.8

PB ICP-MS / PB XRF
CORRELATION CO. 0.996



There are some advantages to using an FP method for standardization compared to site specific soil standards. The FP method can use readily available, well-characterized SRMs to measure analyte sensitivities. Site specific soil standards, by contrast, are usually collected with a separate sampling mobilization. The FP method standardized with SRMs can provide accurate analyte concentrations to be determined in samples with fairly wide matrix variations without restandardization, unlike methods incorporating site specific standards.

RESULTS

Table 2 lists the lower limits of detection determined using the two sets of spectral acquisition conditions (Table 1). The pertinent equation is: $LLD (ppm) = 3 \cdot \sqrt{I_b / m \cdot \sqrt{T}}$, where I_b is the background intensity (cps), m is the analyte sensitivity (cps/ppm), and T is the acquisition livetime in seconds (6). Calculated LLD values are dependent upon spectrum acquisition times, sample matrix, and excitation conditions. The conditions in Table 1 were selected to optimize the Pb and Cd spectral regions. Improved LLDs are possible with EDXRF using longer spectrum acquisition livetimes and optimized excitation conditions for selected spectral regions.

Results for the determination of four analytes by EDXRF in 180 samples (43 cores at 4 levels, two SRMs, three samples in triplicate) were compared to independent analysis results in order to evaluate the level of agreement between the two methods. Table 3 lists the correlation plot data for the analytes in terms of actual slope, intercept, errors, and the correlation coefficient of the fit. Each analyte correlation plot included approximately 150 data points.

ANALYTE	SLOPE	INTERCEPT	CORRELATION COEFFICIENT
Pb	1.01 ± 0.03	10.0 ± 13.8	0.96
As	1.08 ± 0.05	0.98 ± 3.54	0.92
Cd	1.02 ± 0.03	3.09 ± 2.19	0.94
Zn	1.02 ± 0.02	63.0 ± 13.6	0.98

Table 3. Correlation plot data for the four analytes of environmental interest.

As shown in Table 3, slopes of the plots for Pb, Cd, Zn, and As are within 8% of 1.00 and all correlation coefficients are greater than 0.92. The calculated slope near 1.00 and correlation coefficients greater than 0.90 indicates agreement between the two analytical techniques. Figure 2 is a plot of 94 data points in the range of 0 to 300 ppm Pb. Figure 3 is a plot of 110 EDXRF and ICP analyzed samples in the range of 0 to 100 ppm Cd and also indicates agreement between the results of the two methods.

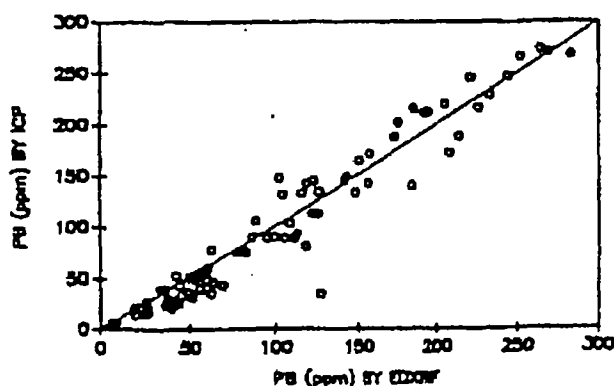


Figure 2. Pb correlation plot for 94 samples.

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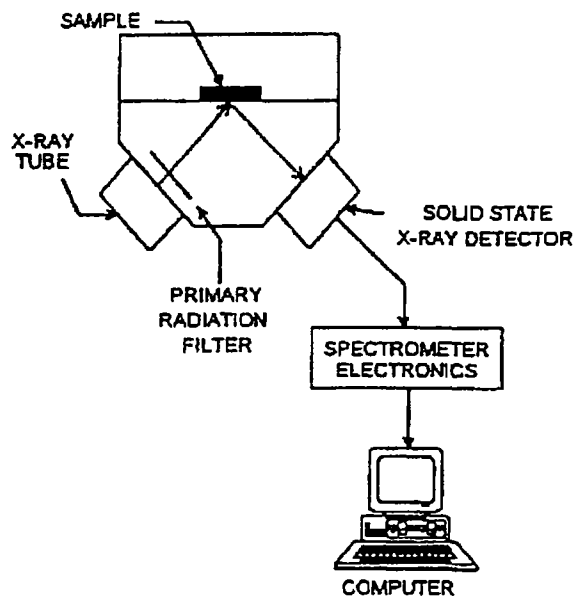
What Is EDXRF?

Energy Dispersive X-ray Fluorescence, or EDXRF, is an instrumental method of chemical analysis that provides qualitative and quantitative identification of elements in solid or liquid samples.

Spectrace EDXRF systems detect elements on the periodic table between atomic numbers 11 (sodium) and 92 (uranium). Samples can be analyzed non-destructively with little or no sample preparation in minutes and in some cases seconds. This capability is further enhanced by the technique's wide dynamic range. Elements in concentrations from as low as a few parts per million to 100% may be analyzed in the same sample simultaneously. Accuracy of less than one percent relative error are attainable with comparable reproducibility.

How Does it Work?

Analysis by EDXRF involves use of ionizing radiation to excite the sample, followed by detection and measurement of X-rays leaving the sample that are characteristic of the elements in the sample.



The Spectrometer electronics digitize the signal produced by X-rays entering the detector, and send this information to the PC for display and analysis.

[More on EDXRF theory](#)

[More on EDXRF hardware](#)

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X-ray Fluorescence Fundamentals

Excitation and Emission

XRF involves use of a beam of radiation from an X-ray tube to ionize atoms in the sample. After an electron is ejected from an inner orbital of an atom, an electron from one of the upper orbitals will drop down to fill the vacancy. When this happens the atom emits a fluorescent X-ray with energy equal to the energy difference in the two levels.

Since the energy difference between the electron orbitals depends on the atomic number of the atom, the energy of the emitted photon identifies the presence of a particular element.

Figure 1 shows a particular electron orbital transition giving rise to a fluorescent X-ray. For a given atom there may be more than one possible transition, and so an element may have several characteristic lines.

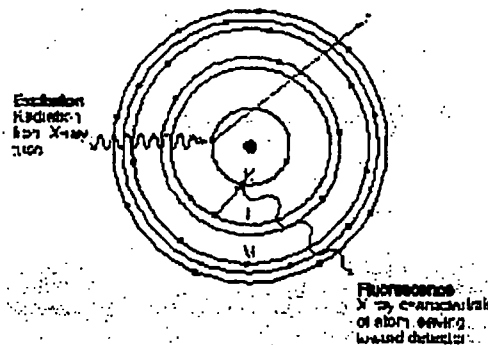


Figure 1 - Excitation occurs when an X-ray photon is absorbed by an atom and an inner orbital electron is ejected. Fluorescence occurs when a photon is emitted by the atom as an outer orbital electron drops down to fill the vacancy. X-ray emissions are designated as K, L, or M, referring to the orbital that is ionized then filled, using the Bohr designations for the orbitals.

Intensity Measurement

In an X-ray spectrum, the presence of an element is evidenced by a peak or series of peaks characteristic of that element. Figure 2 is the spectrum of a filter debris sample, showing the characteristic emissions lines for Cr, Fe and Ni. Peak location on the energy axis identifies the element.

Intensity is measured as the peak area, and is proportional to the loading or concentration of the element present in the sample. For samples less than 1 μm in thickness, the intensity is proportional to the mass per unit area of the element. For a given thickness of sample, or for a very thick sample, the peak intensity is proportional to the weight percent of the element in the sample.

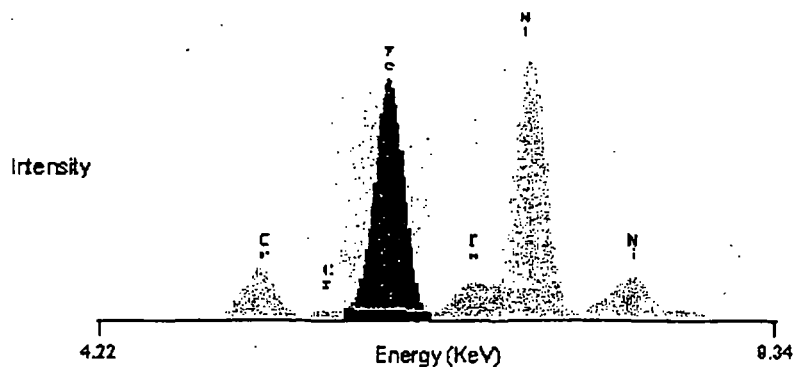


Figure 2 - typical spectrum of a filter sample. Intensity is measured in counts. The dark area is the peak area for iron.

X-ray Absorption

Source X-rays striking a pure material, as shown in Figure 3, with intensity I_0 are absorbed by the material resulting in an attenuated intensity, I , passing through. The following equation describes this relationship,

$$I = I_0 e^{-(\mu/\rho) \rho t}$$

where:

- (μ/ρ) - mass absorption coefficient;
- (ρ) - density (g/cm³) of the material;
- (t) - thickness of the sample

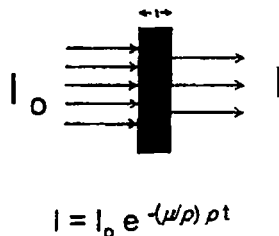


Figure 3 - The effect of X-rays passing through matter is described by Beer's law.

XRF Intensity as a Function of Thickness

Figure 4 shows the theoretical relationship of sample thickness for a homogenous thin film to XRF intensity. As the figure shows, a sample's thickness can be classified as being in one of three categories, infinitely thin, intermediate, and infinitely thick.

Infinitely Thin:

For very thin samples there is a linear increase of intensity with thickness. For these samples the thickness can easily be measured by XRF. The thickness

limit for a sample to be infinitely thin depends on the elemental composition, but is typically 1 micron for most alloys.

Intermediate Thickness:

Samples in this thickness range show a logarithmic increase in intensity with thickness. For samples such as this XRF can be used to measure thickness, but use of an algorithm called Fundamental Parameters (FP) is required. Typically the intermediate range ends at a thickness of 10 microns.

Infinitely Thick :

Samples that are infinitely thick show little or no increase in intensity with increasing thickness. So thickness cannot be measured.

The implication of this thickness effect for filter debris analysis is that sample thickness can be measured for Infinitely Thin and Intermediate samples only. Also, if there are particles larger than 10 microns in the debris, the spectrometer response will be proportional to the area of the particles rather than the mass of the sample.

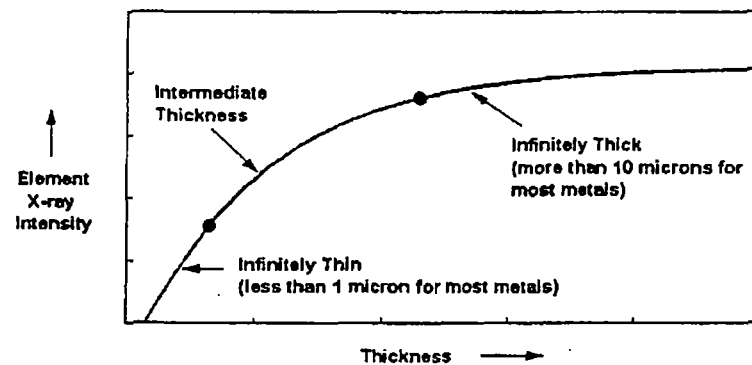


Figure 4 - Plot showing the relationship of sample thickness to X-ray intensity.

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**LOW CONCENTRATION SOIL CONTAMINANT
CHARACTERIZATION USING EDXRF ANALYSIS**

AR. Harding

INTRODUCTION

Effective assessment and remediation of hazardous waste sites dictates that analytical methodologies be developed which assist in the evaluation of site contamination and simultaneously make efficient use of sampling time and resources (1). Optimally, a technique would provide on-site personnel with immediate and accurate information concerning the identity and concentration of inorganic soil contaminants (2).

Inorganic pollutants can be readily determined in contaminated soils with energy dispersive X-ray fluorescence spectrometry (EDXRF) using a thermoelectrically cooled Si(Li) detector (3). A field mobile laboratory van or trailer can accommodate the EDXRF system because the electrically cooled detector, which provides high resolution EDXRF spectra, does not require cryogenic cooling. Soil sample preparation for EDXRF analysis is minimal, therefore, short turnaround times are realized between sampling and reporting results.

This report will describe an EDXRF method developed to determine four inorganic soil contaminants: lead, arsenic, zinc, and cadmium at four sampling depths. The EDXRF results for approximately one hundred eighty soil samples will be compared to results obtained for sample splits submitted for analysis at an independent laboratory. Evaluation of low concentration arsenic detectability with elevated lead concentrations in these samples will be discussed. Accuracy and precision of the EDXRF method will also be compared to the independent methods using a standard reference material and soil samples submitted in triplicate to both laboratories.

EXPERIMENTAL

The field mobile EDXRF spectrometer used in this work was a Spectrace 6000 (KevexSpectrace, Sunnyvale, CA). The EDXRF system consists of three modules: the spectrometer, the control/pulse processing electronics, and the data analysis computer. The compact size and weight (90 lbs.) of the modules permits installation of the system in a laboratory trailer or van.

The bench top spectrometer module, which can accommodate a single soil sample, is powered by 110 V line or generator feed. The excitation source used is a low powered Rh anode X-ray tube (50 KV, 0.35 mA (17 W) maximum output) positioned at a 45° incident angle to the sample. Three primary radiation filters permit optimum spectral acquisition conditions to be computer selected.

The thermoelectrically cooled Si(Li) X-ray detector is mounted at a 45° take-off angle in an inverted geometry with respect to the sample. The 20 mm² Si(Li) crystal, which is protected by a 0.5 mil Be window, is cooled to -90°C for operation using a multi-stage thermoelectric (Peltier effect) cooler. The 300 watts produced at the detector heat sink are dissipated by forced ambient air. Thermoelectrically cooled detectors provide typical resolutions of 185 eV (Mn Ka).

A card cage module is interfaced between the spectrometer and a personal computer.

The card cage components include the detector high voltage supply, the pulse processing electronics, and the control circuit board for the EDXRF spectrometer. The data analysis software executed on the PC is capable of either a fundamental parameters or empirical data treatment scheme using a combination of standard reference materials and/or site specific standards.

Sampling of the suspected waste site was performed using EPA approved protocols in a 9500' x 3500' rectangular area. Forty-three (43) cores were collected and partitioned into four depth levels: surface to 2"; 2" to 6"; 6" to 12"; and 12" to 18", and designated levels 1 through 4, respectively. At the site, samples were first homogenized and then split into two fractions. One was submitted for EDXRF analysis and the other sent to an independent lab for analysis.

The independent laboratory used EPA SW 846 (methods 3050 and 6010) methodology to determine Cd, Pb, and Zn concentrations in the soil sample splits. Arsenic was determined in those splits using SW 846 method 3050 and EPA method 206.4 (spectrophotometric).

Sample preparation for EDXRF analysis consisted of drying the sample for 4 minutes in a microwave oven followed by sieving the dried sample. Material passing through the 2 mm sieve was collected as sample and was free of large foreign objects such as pebbles and sticks. Drying the sample was required due to the variable moisture content in the submitted soils; some surface samples had the consistency of mud. The sieved soil was then ground in a Spex shatterbox grinder (Spex Ind., Edison, NJ) using tungsten carbide cups for 2 minutes. Grinding cups were subsequently cleaned using soap and tap water. The cleaned cups were rinsed with distilled/deionized water followed by isopropanol. Approximately 5 grams of prepared sample were poured into a disposable 32 mm X-ray sample cup and covered with a 6.3 μ m polypropylene film. Five grams of dried sample gave the equivalent of a 15 mm sample depth in the cup. Approximately twenty-five samples were prepared and analyzed per day.

STANDARDIZATION METHOD

Two sets of excitation conditions were employed to determine seven elements in the soil samples, four of which are of specific environmental concern: Zn, As, Pb, and Cd. Table 1 lists the two sets of spectral acquisition conditions and which conditions were used to determine each analyte.

SPECTRAL REGION	CONDITIONS	ANALYTES
MID Z	35 KV, 0.35 mA, 0.13m Rh filter, 200 s livetime	Mn, Fe, Cu Zn, Pb, As
HIGH Z	50 KV, 0.35 mA, 0.63mm Cu filter, 200 s livetime	Cd

Table 1. Spectral acquisition conditions for the EDXRF analysis of soils.

Figure 1 is a mid Z spectrum of a soil sample that was found to contain 125 ppm As, 1100 ppm Pb, and 729 ppm Zn. A multiple linear least squares peak fitting routine was used for deconvolution of overlapped peaks.

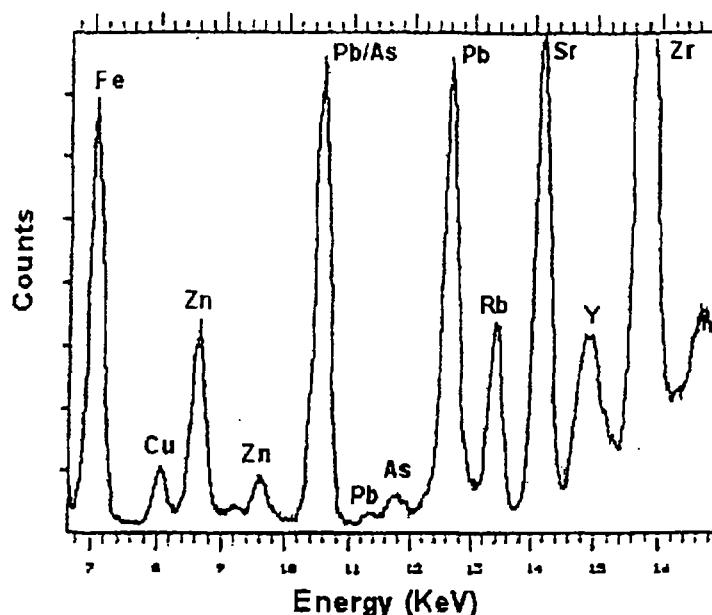


Figure 1. Mid Z spectrum of a soil sample containing 1100 ppm Pb, 729 ppm Zn, and 125 ppm As. Full scale on the y-axis is 2,000 counts.

The soil characterization method was standardized using four standard reference materials (SRM): NBS 1648 (urban particulate); NBS 2704 (river sediment); SO-1 and SO-3, two soil standards available from the Canada Centre for Mineral and Energy Technology. Standards labeled NBS are available from the National Institute for Standards and Technology (NIST). These SRMs have certified concentrations of Fe, Mn, Cu, Zn, Pb, and Cd.

A fundamental parameters (FP) method (5) was employed as the data treatment scheme and used certified concentrations of Fe, Mn, Cu, Zn, Pb, and Cd in the four standard materials. To compute instrumental sensitivity (emission peak counts per second per ppm), the balance of the standard was assumed to be comprised of SiO₂ to account for the contribution of the matrix on the measured analyte X-ray intensity. The balance component SiO₅ was selected to mimic the concentration of Si and O in typical soils, approximately 24% Si and 45% O. Since none of the selected SRMs contain arsenic, As sensitivity (cps/ppm) was determined using a fundamental parameters theoretical calculation based on the computed Zn sensitivity. Table 2 lists the analyte sensitivities computed by the FP method.

ANALYTE	SENSITIVITY (cps/ppm)	LLD (ppm)
Mn	0.010	21
Fe	0.015	19
Cu	0.046	26
Zn	0.067	19
Pb	0.084	7
As	0.132	12
Cd	0.107	4

Table 2. Sensitivity and lower limits of detection for the analytes of interest.

There are some advantages to using an FP method for standardization compared to site specific soil standards. The FP method can use readily available, well-characterized SRMs to measure analyte sensitivities. Site specific soil standards, by contrast, are usually collected with a separate sampling mobilization. The FP method standardized with SRMs can provide accurate analyte concentrations to be determined in samples with fairly wide matrix variations without restandardization, unlike methods incorporating site specific standards.

RESULTS

Table 2 lists the lower limits of detection determined using the two sets of spectral acquisition conditions (Table 1). The pertinent equation is: $LLD (ppm) = 3 \cdot \sqrt{(b/m \cdot \sqrt{T})}$, where b is the background intensity (cps), m is the analyte sensitivity (cps/ppm), and T is the acquisition lifetime in seconds (6). Calculated LLD values are dependent upon spectrum acquisition times, sample matrix, and excitation conditions. The conditions in Table 1 were selected to optimize the Pb and Cd spectral regions. Improved LLDs are possible with EDXRF using longer spectrum acquisition lifetimes and optimized excitation conditions for selected spectral regions.

Results for the determination of four analytes by EDXRF in 180 samples (43 cores at 4 levels, two SRMs, three samples in triplicate) were compared to independent analysis results in order to evaluate the level of agreement between the two methods. Table 3 lists the correlation plot data for the analytes in terms of actual slope, intercept, errors, and the correlation coefficient of the fit. Each analyte correlation plot included approximately 150 data points.

ANALYTE	SLOPE	INTERCEPT	CORRELATION COEFFICIENT
Pb	1.01 ± 0.03	10.0 ± 13.8	0.96
As	1.08 ± 0.05	0.98 ± 3.54	0.92
Cd	1.02 ± 0.03	3.09 ± 2.19	0.94
Zn	1.02 ± 0.02	63.0 ± 13.6	0.98

Table 3. Correlation plot data for the four analytes of environmental interest.

As shown in Table 3, slopes of the plots for Pb, Cd, Zn, and As are within 8% of 1.00 and all correlation coefficients are greater than 0.92. The calculated slope near 1.00 and correlation coefficients greater than 0.90 indicates agreement between the two analytical techniques. Figure 2 is a plot of 94 data points in the range of 0 to 300 ppm Pb. Figure 3 is a plot of 110 EDXRF and ICP analyzed samples in the range of 0 to 100 ppm Cd and also indicates agreement between the results of the two methods.

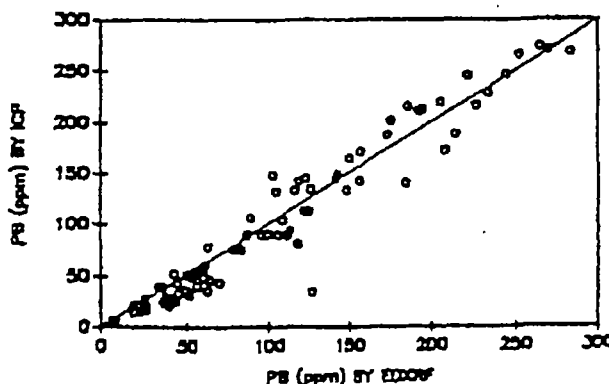


Figure 2. Pb correlation plot for 94 samples.

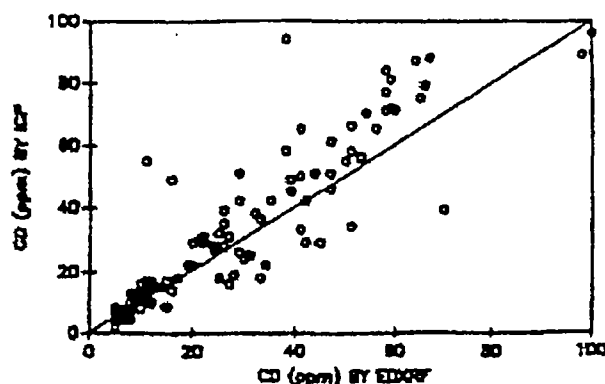


Figure 3. Cd correlation plot for 110 samples.

ACCURACY AND PRECISION

To evaluate the accuracy provided by the EDXRF method two SRMs were submitted as unknowns for EDXRF analysis as well as being submitted to the independent lab for analysis. Table 4 lists the results for SRM SO-2. EDXRF analysis of SO-2 provides results that are in good agreement with certified values. The independent ICP analysis of zinc in SO-2, however, is biased low by a factor of one-half.

Sample	Analyte	ICP	EDXRF	Certified
SO-2	Pb	19	17	21
	Zn	55	123	124

Table 4. Results of the analysis of SRM SO-2 by ICP and EDXRF methods. All values in ppm.

Precision was evaluated by submitting three samples a total of three times for independent and EDXRF analysis. Table 5 shows the results for the two methods along with the calculated standard deviation (in ppm) of the three replicate analyses. Note that Cd in sample C was only reported by EDXRF to the nearest 1 ppm and three values of 9 ppm Cd were determined, hence the zero standard deviation for the three replicates. EDXRF precision is better than 10% relative standard deviation in all but one case (As in sample C) and compares well with that provided by the independent lab.

Sample	Element	Ind. Lab	EDXRF
A	As	45 ± 4	41 ± 3
	Cd	20 ± 2	31 ± 3
	Pb	286 ± 28	312 ± 12
	Zn	185 ± 15	134 ± 10
B	As	17 ± 3	14 ± 1
	Cd	80 ± 6	58 ± 4
	Pb	141 ± 15	158 ± 3
	Zn	556 ± 39	529 ± 46
C	As	17 ± 1	19 ± 4
	Cd	10.0 ± 0.9	9 ± 0
	Pb	117 ± 8	142 ± 14
	Zn	173 ± 26	128 ± 3

Table 6. EDXRF and independent lab results for three soil samples each analyzed in triplicate. All values in ppm

CONCLUSION

Field mobile EDXRF analysis of soils suspected of being contaminated provides information concerning the nature, extent, and magnitude of the contamination. Due to the minimal sample preparation necessary for EDXRF analysis, sampling to result turnaround time is relatively short so the most effective use of sampling resources is realized. EDXRF detection limits below 20 ppm were obtained for the elements of environmental concern. The effect of increasing lead concentration on arsenic detectability was quantified. Using the EDXRF method described here, reliable As results were found for those samples containing As/Pb concentration ratios above 0.083. Accuracy and precision for the analytes of interest using the EDXRF method was shown to be comparable to results obtained by independent analysis. Comparable results for Cd, As, Pb, and Zn between independent and EDXRF methods validates the use of EDXRF analysis for hazardous waste site investigation and remediation.

ACKNOWLEDGMENT

The author would like to acknowledge James P. Walsh and Associates for site sampling and providing the independent analysis data.

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[Back to Applications page](#)

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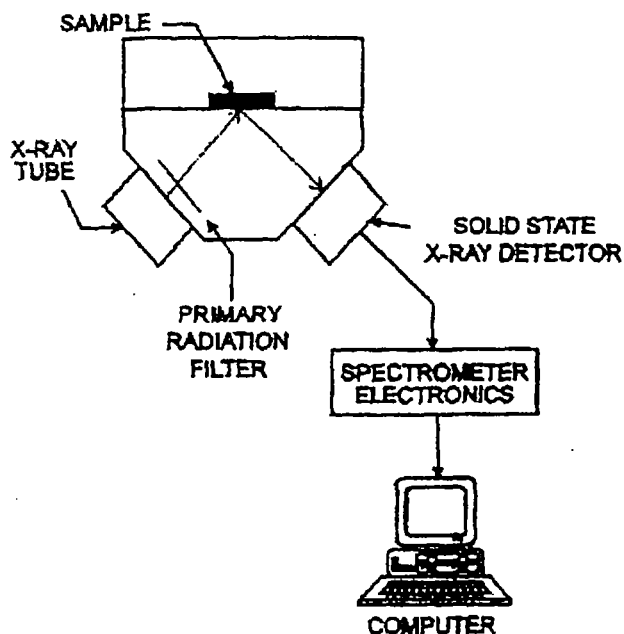
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Components of the XRF Spectrometer

The type of systems produced by KeveX Spectrace are Energy Dispersive XRF (EDXRF) analyzers with a solid state silicon detectors. This type of XRF system is called an Energy Dispersive because the detector is used to measure the energy of the X-ray photons from the sample without the need for a diffracting crystal.

Other types of XRF spectrometers include Wavelength Dispersive XRF (WDXRF) and EDXRF spectrometers using proportional counters. WDXRF systems have better resolution than EDXRF systems but are larger, more expensive, and not considered transportable. EDXRF spectrometers that use gas filled proportional counters do not have the resolution to separate emission lines of elements close in atomic number and are effective over a more limited energy range.

The components of the EDXRF spectrometer are the X-ray tube, detector, and a PC computer based analyzer.



Block diagram showing the components of the EDXRF spectrometer.

XRF Hardware

KeveX Spectrace systems are equipped with silicon detectors that resolve the primary emission lines of adjacent elements and can analyze all elements from sodium and up in atomic number. The detector can be either electrically cooled using a Peltier device, or liquid nitrogen cooled.

The principle advantages of a system like this are that there are few moving parts, making the system relatively stable and insensitive to vibration. Furthermore, the system is small enough to be moved in the back of a van or utility vehicle, and has frequently been setup in the mobile laboratories used by environmental contractors.

HYDROMETRICS' LABORATORY ANALYSIS PLAN

LABORATORY ANALYSIS PLAN

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TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION	1-1
2. QUALITY ASSURANCE POLICY STATEMENT.....	2-1
3. QUALITY ASSURANCE MANAGEMENT AND RESPONSIBILITIES	3-1
4. SAMPLE HANDLING AND DISPOSAL.....	4-1
5. DATA MANAGEMENT	5-1
6. ANALYTICAL METHODS	6-1
7. CALIBRATION/QC PROCEDURES	7-1
8. CORRECTIVE ACTION.....	8-1
9. FACILITIES AND EQUIPMENT	9-1
9.1 INSTRUMENTATION	9-1
9.2 LABORATORY FACILITIES.....	9-1
9.3 ELECTRONIC SYSTEMS	9-1
9.4 LABORATORY REAGENTS AND STANDARDS	9-1
10. AUDITS	10-1
11. QUALITY ASSURANCE REPORTS TO MANAGEMENT.....	11-1
12. CALIBRATION STANDARDS FOR THE FUNDAMENTAL PARAMETERS METHOD.....	12-7
13. METHOD OF CALIBRATION.....	13-7
14. A) EQUIPMENT.....	13-8

LIST OF TABLES

	<u>Page</u>
TABLE 6-1. ANALYTICAL SERVICES.....	6-2
TABLE 6-2. ELEMENTS AND INSTRUMENT DETECTION LIMITS FOR X-RAY FLUORESCENCE SPECTROMETRY ANALYSIS OF SOILS	6-3
TABLE 6-3. XRF PERFORMANCE ON SELECTED NIST STANDARD REFERENCE MATERIALS	6-4
TABLE 8-1. CORRECTIVE ACTION REQUIREMENTS	8-2

LIST OF FIGURES

	<u>Page</u>
FIGURE 5-1. DOCUMENT, SAMPLE AND DATABASE FLOW.....	5-2

LIST OF ATTACHMENTS

ATTACHMENT I. LABORATORY PERSONNEL SUMMARY RESUMES	
ATTACHMENT II. EXAMPLE CHAIN-OF-CUSTODY FORM	
ATTACHMENT III. XRF ANALYSIS STANDARD OPERATING PROCEDURES	

1. INTRODUCTION

The purpose of this Laboratory Analysis Plan (LAP) is to set forth clear policies and standard operating procedures for the analysis of samples by Hydrometrics, Inc. The company of consulting scientists and engineers, founded in 1979 at Helena, Montana, now operates offices in several states and is active in many engineering and environmental remediation projects in the United States and abroad. Hydrometrics offers analytical services through its laboratories in East Helena, Montana and Ruston, Washington. Both laboratories provide elemental soil analyses by X-Ray Fluorescence Spectrometry (XRF). Each laboratory will typically analyze over 10,000 samples per year by XRF. This non-destructive analytical technique is especially suitable when accurate results are needed quickly. In addition to XRF elemental analyses, the East Helena laboratory performs more traditional soil analyses. This document reflects procedures as they are currently being conducted at these laboratories. This LAP will be revised as necessary to reflect modifications in personnel, policies, procedures, instrumentation, parameters, or environmental matrices analyzed.

2. QUALITY ASSURANCE POLICY STATEMENT

Hydrometrics, Inc. Laboratories in East Helena, Montana and Ruston, Washington, are committed to conducting all analyses in accordance with the policies and procedures outlined in this plan in order to ensure that data of the highest quality are consistently generated in the shortest possible turnaround time. Hydrometrics is committed to generating data which are scientifically valid, and which meet or exceed the specific quality assurance goals set forth in this document. In order to do this, the laboratories will regularly monitor laboratory performance and take corrective actions, as necessary and in a timely manner, to meet or exceed project-specified data quality objectives for the following parameters:

- ⇒ **Precision** measures the reproducibility of measurements under a given set of conditions. Precision assessed by replicate measurements of the same sample and is usually stated in terms of standard deviation or coefficient of variation.
- ⇒ **Accuracy** measures the bias in an analytical system. Accuracy is assessed by analysis of field and laboratory spikes and samples of known value, and is stated in terms of percent recovery.
- ⇒ **Representativeness** expresses the degree to which sample data accurately and precisely represent the population being measured. The representativeness criterion is best satisfied by proper selection of sampling points and ensuring that a sufficient number of samples are collected.
- ⇒ **Completeness** is the percentage of measurements made which are judged to be valid. The goal is for enough valid data to be generated to allow proper decisions to be made. It is important that critical samples be identified and that they be properly analyzed.
- ⇒ **Comparability** expresses the confidence with which one data set can be compared to another. Sample data should be comparable with other measurement data for similar samples and sample conditions. This goal is

achieved by using standard techniques to collect and analyze representative samples and reporting analytical results in appropriate units.

In addition to daily quality control analyses, the laboratory will use information gained from audits and data validation reports prepared for specific projects to improve laboratory performance. Hydrometrics is also committed to eliminating the opportunity for transcription errors by implementing an electronic data transfer system through which analytical results are electronically transferred into project databases. Through these processes of daily inspection of instrument performance data, regular monitoring of precision and accuracy performance relative to targets, timely incorporation of corrective actions, laboratory performance audits, and electronic transfer of results from the instrument to a project database, the laboratories demonstrate their commitment to quality assurance.

3. QUALITY ASSURANCE MANAGEMENT AND RESPONSIBILITIES

The ultimate responsibility for assuring that the quality of data generated by the Hydrometrics' Laboratories in East Helena and Ruston meet the specifications set forth in this LAP lies with the President of Hydrometrics; the direct responsibility lies with the Technical Director. The Laboratory Supervisor will provide technical support and generate and review quality assurance products. The Laboratory Technician will provide the first level of data review and monitoring of instrument performance on an ongoing basis. Quality assurance performance evaluation and external data validation will be conducted on a project-specific basis. Validation will be performed either by Hydrometrics' data validation staff in Helena, Montana, or by independent companies with specific expertise in data validation and data quality review. The Supervisor of Environmental Chemistry and Quality Control in the Helena office of Hydrometrics is responsible for the integrity of the XRF results database, the project databases to which XRF instrument results are electronically transferred, the validation of XRF data, and the incorporation of data validation results into the project database. The Supervisor of Environmental Chemistry and Quality Control is the Quality Assurance Officer (QAO) for Hydrometrics, Inc.

4. SAMPLE HANDLING AND DISPOSAL

All samples received by the Hydrometrics Laboratories should be accompanied by a Chain-of-Custody form, (HFORM-1-4/95). Upon receipt, samples are logged in according to standard login procedures then distributed to the laboratory personnel responsible for preparation and analysis. Samples are either locked up or under visual surveillance at all times. After analysis, samples are stored in a locked archive for project-specified periods or for at least one year. After that time period samples are returned to the client, kept in storage or disposed of according to appropriate regulatory guidelines.

5. DATA MANAGEMENT

Hydrometrics is committed to maintaining the integrity of the data after it has been generated in the field or the laboratory. To this end, Hydrometrics has developed, tested and installed a program that enters data directly from the XRF instrument to the Archive database, thereby eliminating data errors due to manual transposition. This database stores results of sample and quality control analyses, sample preparation information, field information, and sample storage locations. The archive database program allows the laboratory to perform calculations to verify and track instrument performance.

Hydrometrics can also provide validation services to verify the correctness of lab and field data, evaluate quality control analyses and identify corrective actions on a project-specific basis. Specific project databases to which laboratory results are transferred, are maintained as read-only files for data users; the Data Validation Group personnel have the sole rights and responsibility for maintaining and editing the project databases. The Archive database also supports this data validation activity.

Sample, document, and database activities are schematically represented in Figure 5-1.

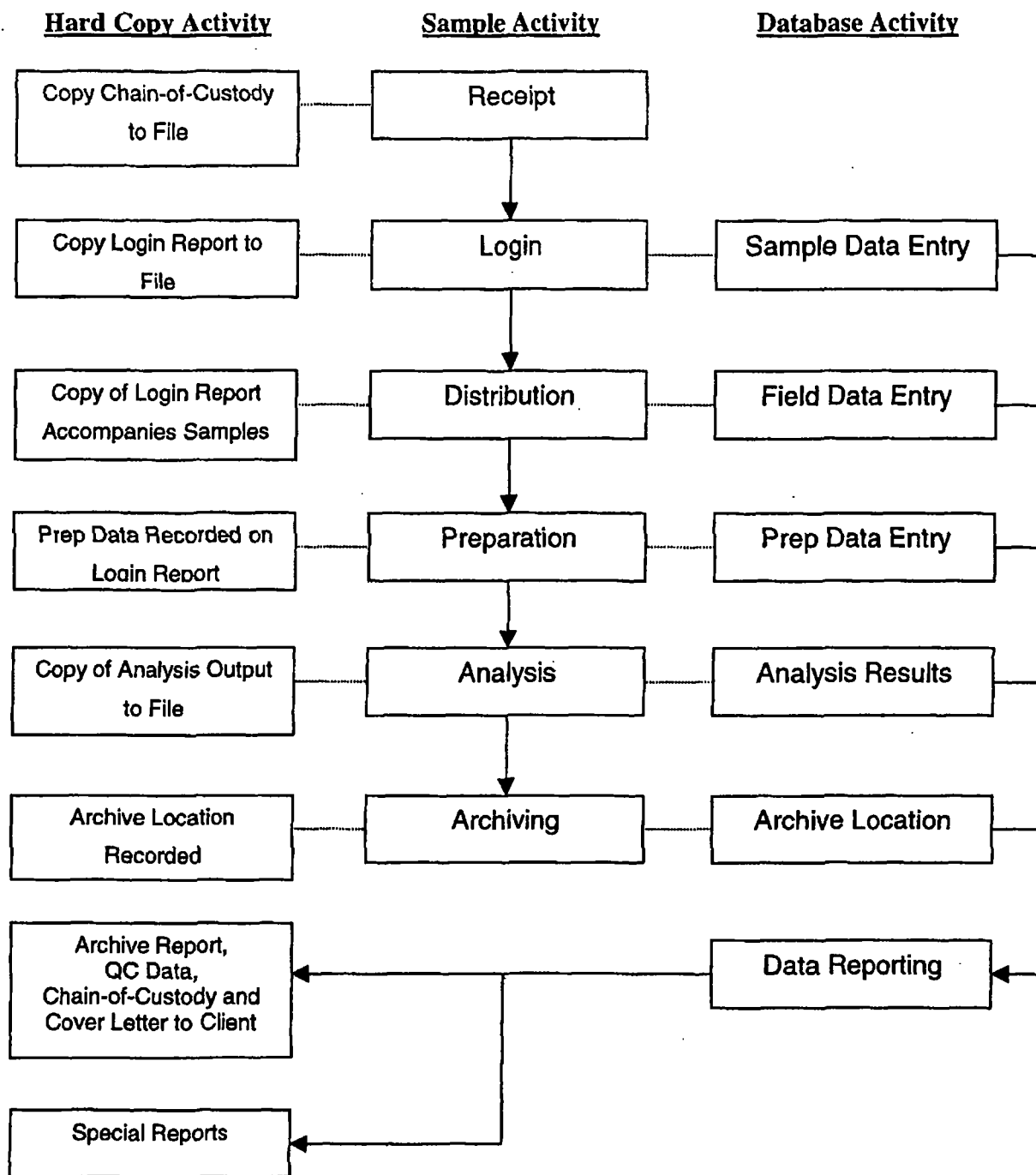


FIGURE 5-1. DOCUMENT, SAMPLE AND DATABASE FLOW

6. ANALYTICAL METHODS

Analytical methods used by the Hydrometrics Laboratories will, insofar as possible, be the reference methods published by recognized authorities such as the Environmental Protection Agency (EPA) or American Society for Testing and Materials (ASTM). The analyses and their reference methods are listed in Table 6-1. X-Ray Fluorescence Spectrometry (XRF) methods of soil analysis are not listed by EPA or ASTM; however, the reference methods are supplied by the manufacturer of the instruments, Spectrace, Inc. Table 6-2 lists the elements analyzed by XRF and their detection limits. Hydrometrics has, on file, ample data comparing traditional wet chemistry elemental analysis of soils with the XRF elemental analysis. The data show an excellent correlation between methods, and EPA has approved the XRF method for several projects. To further demonstrate the accuracy and precision of XRF analyses, statistics have been compiled for XRF performance on selected NIST Standard Reference Materials (See Table 6-3). Fundamental parameter analyses are presented for several elements and matrix specific analyses are presented for cadmium, lead and arsenic.

TABLE 6-1. ANALYTICAL SERVICES

<u>TEST NAME</u>	<u>METHOD</u>	<u>SAMPLE SIZE</u>
Arsenic Speciation	USGS W.F. Ficklin	100 ml
Atterberg Limits	ASTM D4138	250 g
Dry Soil Preparation	ASTM D421	Varies
Elemental Analysis by XRF	Spectrace, Inc.	100 g
Lime Content	ASTM C25	10 g
Moisture Content	ASTM D2216	50 g
Paint Filter Liquids Test	EPA SW-846.9095	100 g
Particle Size Analysis	ASTM D421, D422	250 g
Permeability	ASTM D2434	250 g
pH	ASTM D4972	250 g
Proctor Standard	ASTM D698	10 lb
Saturation Percentage	USDA Handbook 60	250 g
Shrinkage Limit	ASTM D4943	100 g
Sodium Absorption Ratio	USGS SAR	250 g
Soil Cement Mixtures	ASTM D558	6 lb
Soil Classification	ASTM D2487	100 g
Soil Paste	USDA Handbook 60	250 g
Specific Gravity	ASTM D854	100 g
TCLP Extraction and Analysis	EPA SW-846.1311	200 g
Turbidity	AWWA 2130 B	250 ml
Weight and Water Content	ASTM D4718	250 g

ASTM American Society for Testing and Materials - Annual Book of ASTM Standards, Section 4, 1996

AWWA American Water Works Association - Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992

EPA United States Environmental Protection Agency

Spectrace Spectrace Instruments, Inc.

USDA United States Department of Agriculture, Handbook 60

USGS United States Geological Survey - Methods for the Collection and Analysis of Water for Dissolved Minerals and Gases, #5, 1907

**TABLE 6-2. ELEMENTS AND INSTRUMENT DETECTION LIMITS FOR
X-RAY FLUORESCENCE SPECTROMETRY ANALYSIS OF SOIL**

<u>ELEMENT</u>	<u>DETECTION LIMITS</u> <u>GOALS</u>
Antimony	30 PPM
Arsenic	10 PPM
Barium	110 PPM
Cadmium	10 PPM
Calcium	100 PPM
Chromium	20 PPM
Cobalt	15 PPM
Copper	10 PPM
Iron	20 PPM
Lead	10 PPM
Manganese	30 PPM
Mercury	10 PPM
Molybdenum	10 PPM
Nickel	20 PPM
Potassium	130 PPM
Selenium	10 PPM
Silver	20 PPM
Strontium	10 PPM
Thallium	10 PPM
Titanium	25 PPM
Vanadium	20 PPM
Zinc	10 PPM

The detection limits above are based on the Fundamental Parameters Program and are a general indication of the lower limit of detection. Because sample matrix can have an effect on detection limits, these numbers may be different for any given project. Often, the limits are lower than stated here.

The formula for calculating detection limit is:

$$DL = \frac{3 * \sqrt{B}}{P} * C$$

where B is the number of background counts, P is the number of peak counts, and C is the concentration of the analyte in the standard being measured.

TABLE 6-3. XRF PERFORMANCE ON SELECTED NIST STANDARD REFERENCE MATERIALS

	Cadmium	Lead	Zinc	Iron	Manganese	Copper	Arsenic	Cadmium	Lead	Arsenic
Analysis Mode	Fundamental Parameters	Fundamental Parameters	Fundamental Parameters	Fundamental Parameters	Fundamental Parameters	Fundamental Parameters	Fundamental Parameters	Matrix Specific	Matrix Specific	Matrix Specific
NIST SRM	2711	2711	2711	2709	2709	2711	2711	2711	2711	2711
True Value (mg/Kg)	41.7	1162	350.4	3.5 (%)	538	114	105	41.7	1162	105
XRF Mean (mg/Kg)	44.6	1087	317	3.05 (%)	526	111	99.1	40.2	1160	110
RSD (%)	6.46	2.70	3.12	16.8	2.06	7.36	7.02	6.88	1.81	7.14
Number of Analyses	39	46	64	40	19	26	21	133	138	133

Data for this table were gathered from analyses done between January 1996 and October 1996.

7. CALIBRATION/QC PROCEDURES

Calibrations of instruments used for analysis will be performed in accordance with the procedures outlined in the reference method or as specified by the instrument manufacturer. In the case of XRF analysis, where no reference method exists, the following calibration scheme is typically followed:

- At least annually, a calibration curve will be generated using appropriate standards for those projects requiring matrix-specific calibration. Typical correlation coefficients for those standard curves are 0.95 or better.
- At the beginning of each day, an energy calibration using a copper disk is performed. If inspection of the instrument parameters shows them to be within specified limits, a reference sample of known concentration is run to verify the energy calibration, and to provide a calibration correction factor. The calibration correction factor must be within 0.98 and 1.02. The calibration curve is then verified using a project-specific standard, the results of which must be within specified limits for analysis of samples to begin. The calibration curve is reverified during the run at project-specified intervals with a reference sample of known concentration.
- Quality control analyses for XRF elemental analyses also consist of at least a duplicate sample or a Laboratory Control Sample run every batch of 16 analyses run through the instrument. Typically, duplicate samples must have a relative percent difference (RPD) of 35 percent or less. Laboratory Control samples must meet percent recovery limits of plus or minus 5 percent to 25 percent, depending on the project. Some projects may require more or fewer QC analyses.
- Quality control analyses, for non-XRF samples, will be run as specified by the reference method or as specified in the project requirements. When no such specifics exist, the following quality control samples will be run.

- ⇒ Blanks will be run at the beginning and end of each run and after every 20 samples.
- ⇒ Duplicates will be run at a frequency of 10 percent or once per run, whichever is greater.
- ⇒ Spikes, where applicable, will be run at a frequency of 10 percent or at least once per run, whichever is greater.
- ⇒ Reference samples or Laboratory Control samples, if available, will be run at a frequency of 5 percent or at least once per run, whichever is greater.

8. CORRECTIVE ACTION

Quality control requirements may vary depending on sample matrix and project requirements. For example, a spiked sample analysis is not required on soil samples undergoing XRF analysis, but is required for TCLP extract analysis. Table 8-1 summarizes normal quality control analyses, frequency of analysis, control limits and required corrective actions.

TABLE 8-1. CORRECTIVE ACTION REQUIREMENTS

QC Analysis	Source	Frequency	Control Limits	Corrective Action Required
Initial or Continuing Calibration Verification, ICV or CCV	Standard Reference Material or In-house Standards	Following Calibration and then 1:16	Project Specific, Typically $\pm 25\%$	Correct Problem and Recalibrate
Energy Calibration for XRF	Copper Disk	Beginning of Each Day	Fast Discriminator Rate < 160	Correct Problem and Recalibrate
Laboratory Control Sample, LCS	Standard Reference Material	Project Specific but at least Daily	Project Specific, Typically ± 5 to 25%	Correct problem, reanalyze batch
Duplicate Sample Analysis	Sample from Batch	1:16 for XRF, 1:10 for non-XRF	Project Specific, Typically RPD < 35%	Flag Samples
Spiked Sample Analysis	In-house Spike Pool	1:10 when applicable, per Method	Project Specific, Typically $\pm 25\%$ Rec.	Correct Problem, Reanalyze
Initial or Continuing Calibration Blanks, ICB or CCB	DI Water	Following Calibration then 1:20	< Detection Limit	Recalibrate
Preparation Blank	DI Digestion Blanks	1 per Batch	< Detection Limit	Correct Problem, Reanalyze

9. FACILITIES AND EQUIPMENT

9.1 INSTRUMENTATION

Both the East Helena Laboratory and the Ruston Laboratory are equipped with identical Spectrace Model 5000 X-Ray Fluorescence Spectrometers, SPEX shatterbox grinding mills, and other associated sample handling and preparation equipment. In addition, the East Helena Laboratory has the necessary equipment, either in-house or available for use off-site to perform all the analyses listed in Table 6-1.

9.2 LABORATORY FACILITIES

The Ruston Laboratory and sample archive occupy 900 square feet in the Hydrometrics facility in Ruston. The East Helena Laboratory and sample archive occupy 890 square feet at the Hydrometrics office in East Helena. Both laboratories minimize possible cross contamination by maintaining separate areas for sample preparation and XRF analysis.

9.3 ELECTRONIC SYSTEMS

Both the Ruston and East Helena Laboratories use identical database systems for the logging, tracking and reporting of sample data. The database system is part of a Novelle network at each site and is supported by the Computer Services Group at Hydrometrics in Helena, Montana. Communication is easily accomplished through an electronic mail program.

9.4 LABORATORY REAGENTS AND STANDARDS

All laboratory reagents will meet or exceed the quality specified by the method. Generally, unless a higher grade is recommended, reagents are ACS grade or better. Purchased standards are from NIST or are NIST traceable. Matrix specific standards are obtained by having actual samples analyzed by a reference method.

10. AUDITS

Both internal and external audits are conducted to verify the existence, implementation, and effectiveness of management systems for quality assurance and quality control of laboratory procedures. Internal audits may be periodically performed by Hydrometrics staff to monitor quality assurance program implementation. The QAO is responsible for conducting performance audits, evaluating audit results, and implementing corrective actions as indicated to maintain high quality laboratory performance. External audits are conducted by regulatory agency personnel, such as the Environmental Protection Agency or Washington Department of Ecology, either in association with specific projects or in order to evaluate the laboratory for certification purposes.

Two types of audits may be conducted: technical systems audits and performance evaluation audits. Technical systems audits (TSAs) are on-site audits directed at an examination of calibration records, sampling and measurement procedures, general laboratory cleanliness, support systems, equipment and facilities, maintenance and repair records, and control charts for accuracy and precision. Technical systems audits include quantitative evaluations of quality assurance/quality control data used to monitor the performance of the total measurement system (e.g., including errors associated with field sample handling procedures as well as laboratory analytical procedures). TSAs are conducted for the purpose of determining conformance with organizational and procedural elements of the LAP as well as of project-specific Work Plans, Sampling and Analysis Plans (SAPs) and Quality Assurance Project Plans (QAPPs). These audits will be conducted at the beginning of each project and during start-up of major operational phases. Additional technical system audits may be performed to address project-specific requirements, and may also be conducted after modifications in laboratory procedures have been implemented and/or at the discretion of the QAO. Noncompliance with procedures and corrective actions taken will be documented and reported in accordance with the specific requirements set forth in project Work Plans.

Performance evaluation (PE) audits are conducted to evaluate technical aspects of laboratory operations, including laboratory technician performance and analytical instrumentation and equipment. A PE audit entails analysis of performance evaluation samples (PESs) of known chemical composition and concentration in an appropriate matrix. PESs may consist of certified standard reference materials, or may be samples prepared from a site-specific matrix for which previous reliable determinations of composition and concentration have been made. The chemical composition and concentration of chemical components in the PES are not known to the Laboratory Technician, XRF Analyst, or any other person handling the sample during the preparation and analysis process. Performance audits will be conducted at a minimum upon project start-up and once annually. Additional audits may be performed to address project-specific requirements, and as deemed necessary by the QAO, to re-establish confidence in laboratory performance when out-of-control circumstances have been observed and corrected. Results of performance evaluation audits will be documented and reported to the Laboratory Supervisor and QAO and to outside agencies as necessary in accordance with the specific requirements set forth in project Work Plans.

Soil samples analyzed by XRF may be submitted to an outside laboratory for wet chemistry confirmation analysis as determined on a project-by-project basis. The criteria for selection of laboratory services subcontractors may vary depending on the specific needs of a given project, however, all laboratories must agree to provide documentation of quality assurance/quality control protocols, standard operating procedures and laboratory quality assurance plans, must allow Hydrometrics or its representatives to conduct an on-site laboratory audit, and must be willing to perform analysis of performance evaluation samples or other quality control samples necessary to meet project-specific requirements. Results of outside laboratory audits will be documented and reported to the QAO.

11. QUALITY ASSURANCE REPORTS TO MANAGEMENT

Laboratory quality assurance reports will be submitted to the QAO on an annual basis, or as required by project sampling and analysis plans, or as frequently as needed, to document laboratory performance with respect to targeted accuracy and precision goals, problems with laboratory performance and corrective actions taken. These reports will be prepared by the Laboratory Supervisor and will include, at a minimum, documentation that reflects accuracy with respect to reference standards analyses, precision with respect to laboratory duplicate analyses, representativeness, comparability and completeness. Results obtained by wet chemistry confirmation analysis will be compared (e.g. RPDs) to those obtained by XRF on an ongoing basis as wet chemistry confirmation results become available. When applicable, comparison of EPA split sample results will also be compared to XRF and wet chemistry confirmation results on an ongoing basis as the split sample results become available from EPA.

This LAP will be reviewed annually by Hydrometrics management responsible for quality assurance and updated as necessary to incorporate any changes in policies, quality assurance reporting procedures, or technical performance requirements with respect to target precision, accuracy, representativeness, comparability and completeness goals established for the laboratory.

ATTACHMENT I. LABORATORY PERSONNEL SUMMARY RESUMES

PROFESSIONAL QUALIFICATIONS

ROBERT J. MILLER

EXPERIENCE

GENERAL

Robert J. Miller, Special Projects Manager, has 20 years experience as a hydrogeologist, project director and CERCLA/regulatory specialist. His experience includes hydrogeological investigations at hard rock and coal mines throughout the western United States. For the last eight years Mr. Miller has been the project director of two of the largest RCRA/CERCLA site cleanups in the United States, the East Helena, Montana, lead smelter and the former copper/zinc smelter in Tacoma, Washington. These projects have required intensive air, soil and water investigations and substantial coordination between the various federal and state agencies, and private parties. Other major projects included a groundwater study at a large petroleum refinery, closure of two railroad tie-treating plants; and the development of water treatment, water monitoring, and spill contingency plans at numerous industrial and mining sites in North America.

EDUCATION

1978 B.S. Geology, University of Wisconsin, Oshkosh, Wisconsin

EMPLOYMENT HISTORY

1997 - Present	Manager of Special Projects, Hydrometrics, Inc., Tacoma, Washington
1994 - 1997	Technical Director/Senior Hydrogeologist, Hydrometrics, Inc., Helena and Tacoma Washington
1991 - 1994	Helena Office Manager/Senior Hydrogeologist, Hydrometrics, Helena, Montana.
1988 - 1991	Senior Hydrogeologist, Hydrometrics, Helena, Montana
1980 - 1988	Hydrogeologist, Hydrometrics, Inc., Helena, Montana
1979 - 1980	Geologist/Soils Technician, Soil Testing Services of Wisconsin, Milwaukee, Wisconsin
1978 - 1979	Hydrogeologist/Geologist, Wright Water Engineers, Inc., Denver, CO

PROFESSIONAL AFFILIATIONS

National Water Well Association

RELEVANT PROJECTS

Hazardous Waste Site Remedial Investigation/Feasibility Study (RI/FS), Site Characterization and Engineering Evaluation for Residential Soils Engineering Analysis and Cost Evaluation (EE/CA), and Site Specific and Residential Remedial Design/Remedial Action (RD/RA) Projects, East Helena, Montana, Superfund Site. Coordinated technical and administrative aspects of RI/FS, RD/RA. Responsibilities included technical and administrative management of multi-disciplinary remedial investigation of various metal and organics contaminated media associated with the Superfund site. These media included groundwater, surface water, soil, air quality, wildlife, and aquatic life. Experience included preparation of all supporting documents including RI/FS work plans, Sample and Analysis Plans (SAP), Health and Safety Plan (HSP), Air Quality Monitoring Plan, Fish and Waterfowl Study Plans, Treatability Study reports, and preparation of RI/FS reports for several operable units. Activities included all technical and document preparation aspects of the RI and FS report including technical and editorial support for site risk assessments. Field and technical evaluation activities included groundwater, surface water, and soil sampling and analysis, aquifer testing, hydrogeologic evaluation, coordination of groundwater flow and contaminant transport modeling. EE/CA responsibilities included residential soil characterization and remedial options evaluation and cost analysis for Residential Soils. RD/RA responsibilities included: preparation of RD/RA work plans, SAPs, and HSPs for remediation of plant site source areas, and for remediation of residential soils in the town of East Helena, Montana; management and supervision of source remediation projects; and initiation of residential soil remediation activities including coordination of initial sampling programs, establishment of XRF analytical procedures, and remediation documentation procedures.

Tacoma Smelter Superfund Site, Tacoma, Washington. Technical and administrative aspects of Remedial Investigation/Feasibility Study (RI/FS), and interim remedial action for the Tacoma Smelter Superfund site. Responsibilities included technical and administrative management of multi-disciplinary Remedial Investigation of various metal and organic chemical contaminated media including groundwater, surface water, soils and air quality associated with the Superfund site. Responsibilities include preparation of RI and FS reports including supporting documents. Activities included all technical and document preparation aspects of the RI and FS report including technical support for the site risk assessment. Field and technical evaluation activities included groundwater, surface water, soil sampling and analysis, aquifer testing, hydrogeologic evaluation, coordination of groundwater flow and contaminant transport modeling, and groundwater remediation modeling. Feasibility study activities included RCRA landfill siting studies, and soil and water treatability studies. Interim remedial action activities include preparation and coordination of site demolition procedures consisting of several documents required by EPA which address site demolition management strategy, surface run-on control, pre-demolition and demolition activities, sampling and analysis of demolition debris and air quality, fire protection, and dust control. RD/RA activities included the following: preparation of RD/RA work plans, and SAPs for remediation of plant site source areas and groundwater controls; preliminary design for source area and groundwater remediation; and technical support for all areas of site RD/RA, including on-site landfill construction, surface water controls, and marine sediment remediation.

Former Amarillo Zinc Smelter Site, Amarillo, Texas. Technical and administrative aspects associated with remedial investigation, design and remedial action for soils, groundwater and surface water for the former Zinc Smelter site in north Amarillo. Investigation activities consisted of sampling, analysis and evaluation of soil, groundwater and surface water on and off the former smelter site. Investigation activities included delineation of soil and water contamination, and included the use of geostatistics, residential soil sampling, site demolition of remaining structures, a feasibility study and remedial action plan for remediation of soil and surface water contamination associated with the site. Post-investigation responsibilities include remedial designs for plant site soils and sediments and coordination of remedial construction activities.

Omaha Lead Refinery Site, Omaha, Nebraska. Technical and administrative aspects associated with remedial investigation and feasibility study (RI/FS) for clean-up of soils, groundwater and surface water impacts associated with metal refining activities at the former lead refinery in Omaha, Nebraska. Investigation activities included sampling, analysis and evaluation of metal and organic contaminants in soils, groundwater and assessment of impacts to the Missouri River. Remedial design activities included a Feasibility Study for site cleanup, and technical support for remedial design.

Glover Smelter Site, Glover, Missouri. Technical and administrative aspects for investigation of metal impacts on site groundwater and soil at the Glover Lead Smelter. Investigation included sample and analysis of soil groundwater and surface water, and evaluation of water sediment and biota in surface water streams. On-going responsibilities include preparation of remedial action plan in accordance with State of Missouri requirements.

Idaho Pole Superfund Site, Montana. Responsibilities consist of technical oversight for the PRP of the State of Montana's site Remedial Investigation and Feasibility Study (RI/FS) of Penta-Chlorophenol contaminated groundwater, surface water and soils. Activities included personal and delegated oversight of field investigation activities, and review and preparation of comments for the states' remedial investigation.

Circle Smelter Superfund Site, Beckemeyer, Illinois. Responsibilities consist of technical oversight for the PRP of the USEPA EE/CA for the Circle Smelter in Beckemeyer, Illinois, including: technical review of on-site and off-site soil, sediment and residential soil investigations; supplemental sample collection and analysis; evaluation; and selection of EE/CA cleanup options; and post- EE/CA remedial design including preparation and implementation of Remedial Design Work Plans, SAPs and QAPPs in accordance with EPA RD/RA requirements for the site.

Rocker Site, near Butte, Montana. Responsibilities included field coordination and remedial investigation of creosote and heavy metals contamination at a former timber framing plant CERCLA site.

Leadville Superfund Site, Leadville, Colorado. Activities included field coordination of monitoring and investigation of high altitude mining impacted water resources. Activities also included technical oversight of Remedial Investigation activities by EPA and State of Colorado.

Former Murray Smelter Site, Murray, Utah. Responsibilities consisted of Project Manager for the Engineering Evaluation/Cost Analysis (EE/CA) for the former Murray Utah Smelter Site. Activities included work scope negotiations with EPA, State of Utah, and PRP, project set-up, and initiation of site EE/CA.

CMC Austin, Minnesota Railroad Yard Fuel Spill Site. Responsibilities for this site included management of remedial investigation (RI) and remedial design (RD) efforts for a former railroad site with diesel fuel contamination of groundwater and soils. Activities included work plan preparation, field management and implementation, data evaluation and RI report preparation. Post-RI activities included preparation of a remedial design plan for free product recovery and remediation of impacted groundwater and sub-surface soils.

CMC Humboldt Yard, Milwaukee, Wisconsin. Responsibilities included project management, technical investigation and report preparation for a former railroad yard site with diesel and gasoline contamination in groundwater and subsurface soils. Activities also included preparation of a preliminary soils and groundwater remediation feasibility study.

Other Major Hazardous Waste Projects. Other contaminant investigation projects included: study of oil wastes at the Billings, Montana, EXXON Refinery hazardous waste sites, including test drilling, data analysis and preparation of permit information; groundwater investigation of petroleum product contamination at sites in Dillon, Great Falls, and Helena, Montana; and field investigation of creosote contamination of surface water and groundwater at two former railroad tie plants in northwestern Montana.

MINING PERMITS AND RECLAMATION

Zortman, Montana. Responsibilities included project management and technical administration for preparation of mining permit applications for hard rock (gold) mines in Zortman and Landusky, Montana. Activities included: design, implementation and subsequent direction of baseline and mining water resource monitoring programs; monitoring well construction; sampling and aquifer testing; preparation of chemical spill contingency plans; hydrogeologic and water supply evaluation; and assessment of potential post-mining impacts including pit dewatering simulations, groundwater flow and quality impacts, assessment of existing and potential future water impacts; and evaluation and cost analysis of post-mining reclamation options.

CX Ranch Mine, Consolidation Coal Company, Decker, Montana. Experience includes preparation of hydrology portions of the mining pit application for the proposed Consolidation Coal Company CX Ranch Mine near Decker, Montana. Field activities included: surface water and groundwater investigation, aquifer testing, monitoring well drilling and installation, infiltrometer tests, and water quality sampling and operation of monitoring systems.

Otter Creek Project, Consolidation Coal, Southeastern Montana. Hydrometrics' tasks included hydrology evaluation of a potential coal mine site in southeastern Montana in preparation for a coal mining permit application. Evaluation activities included: surface water and groundwater investigations, monitoring well drilling and installation, aquifer testing, continuous and instantaneous streamflow monitoring, surface water and groundwater quality sampling and evaluation, and long-term operation of monitoring systems.

Shell Youngs Creek Mine, Southeastern Montana. Experience includes field investigation and permit application preparation of the hydrology portions for a proposed coal mine in southeastern Montana.

Shell Pearl Project, Northern Wyoming. Hydrometrics' tasks consisted of a hydrology evaluation of a potential coal mine site in northern Wyoming in preparation for a coal mining permit application. Evaluation activities included: surface water and groundwater investigations, monitoring well drilling and installation, aquifer testing, continuous and instantaneous streamflow monitoring, surface water and groundwater quality sampling alluvial valley floor (AVF) delineation, and evaluation of the interaction of coal and alluvial aquifers, and streamflow.

Other Mining Projects. Preparation of hydrology portions of permit applications for the Westmoreland coal mine in southeastern Montana; drilling, completion and aquifer testing of monitoring wells for Chevron Company's Stillwater platinum/palladium mine near Nye, Montana; supervision of drilling and extensive aquifer testing at two proposed strip coal mines near Gillette, Wyoming; and performance of a water resources inventory and investigation associated with lignite coal mines in North Dakota.

Other Geologic, Soil or Water Resource Investigation Experience. Other technical support responsibilities have included: drilling and development of community, recreational and industrial water supplies; development of monitoring programs for hazardous waste sites and solid waste landfill sites; aquifer flow and contaminant simulations, aquifer testing, drilling and installation of monitoring wells; technical support and review of spill contingency plans, air, water and soil quality monitoring plans, health and safety plans, and other related or similar documents.

Geologist and Soils Technician. Responsibilities included field investigations and identification of soil and rock samples, resistivity surveys for commercial gravel properties, and field and laboratory testing of soil prior to and during construction projects.

Hydrogeologist/Geologist. Experience included: Project coordinator and field engineer for hydrology investigation of a uranium mine in southern Colorado including: aquifer testing and evaluation; coordination of major drilling programs; mapping and analysis of subsurface hydrology and geology; drainage basin investigations; water monitoring and sampling programs; and hydrologic investigations for residential, municipal, and recreational developments.

Other projects included investigation of a major fuel spill into groundwater in Montevista, Colorado, and design and implementation of a fuel recovery system, geologic logging and design assistance for community and recreational water supplies. Experience included geologic and geophysical log analysis and interpretation, design, construction and development of piezometers and pumping wells, and installation and maintenance of surface water projects.

EXPERT WITNESS EXPERIENCE

Technical Expert Witness for Site Suitability Hearing; Hennepin County, Minneapolis, Minnesota. Experience included expert witness testimony on technical aspects of a former railroad property site in Minneapolis, Minnesota. Issues involved the site suitability for future development as commercial property and potential impacts and liabilities to the county if the site were incorporated into county development plans. Technical testimony included personal and company qualifications, and description and professional opinions relative to the technical nature of the site, including hydrogeology and extent of subsurface contamination from historic fuel operations.

Legal Deposition; Fuel Spill Site, Great Falls, Montana. Experience included deposition as technical support during legal proceedings relative to assessment of liabilities regarding a former retail fuel site in Great Falls. Issues involved subsequent site development for retail commercial use, and responsibilities for past historic fuel contamination. Testimony included personal and company qualifications, and professional opinions and findings of site investigation conducted by Hydrometrics.

Legal Deposition; Fuel Spill Site, Dillon, Montana. Experience included deposition as technical support during legal proceedings relative to assessment of liability regarding shallow aquifer contamination from fuel losses in the community of Dillon, Montana. Issues involved delineation of contaminant areas and identification of sources of shallow aquifer contamination in the community. Testimony included personal qualifications, and professional opinions and findings of an investigation of groundwater contamination conducted by Hydrometrics on behalf of the State of Montana Department of Health and Environmental Sciences.

Technical Witness; Landfill Site Suitability Public Hearing, Jefferson County, Montana. Experience consisted of technical witness during public hearing on a landfill site suitability hearing. Testimony included description of professional and company qualifications, summary of site investigation conducted by the company, and professional opinions on site suitability as a landfill. Technical issues included site geology and hydrogeology, and assessment of potential impacts from operations of the site as a solid waste landfill facility.

PROFESSIONAL QUALIFICATIONS

ANDY V. LEWIS

EXPERIENCE

GENERAL

Mr. Lewis is a lab technician in Hydrometrics' Ruston, Washington, XRF laboratory. His duties include X-Ray Florescence (XRF) analysis of soil samples, field sampling, sample preparation, calibration and maintenance of the XRF, and the preparation of soil data reports.

EDUCATION

1994 Technical degree in Environmental Sciences & Technology, Clover Park Technical College, Tacoma, WA
1995 Water Technician Certification, Clover Park Technical College, Tacoma, Washington

SPECIAL TRAINING AND AWARDS

Niton Corporation Manufacturers Training Course for the Niton XRF Spectrum Analyzer - 1998
Arsenic and Lead Hazardous Material Personal Protection and Safety Training, Hydrometrics - 1998
Washington Department of Ecology Internship with the Toxic Cleanup Division, UST Section - 1995
80 hours Hazardous Materials Personal Protection & Safety Training, Clover Park Technical College, June 1994
Ambient Monitoring, Salmon Spawning Gravel Composition, Northwest Indian Fisheries Commission - 1994
Puget Power Wildlife Habitat Enhancement Project - 1993 Foss Environmental Internship Program - 1994
Pierce County Soil Conservation and Environmental Protection Agency's Stream Walk Program 1995-1997
Adult CPR and Standard First Aid - 1995-98

EMPLOYMENT HISTORY

1997 - Present Lab Technician, Hydrometrics, Inc., Ruston, Washington
1995 - 1997 Lab Technician (Temporary), Hydrometrics, Inc., Ruston, Washington
1995 Laborer, OnSite Environmental, Bellevue, Washington

RELEVANT PROJECTS

Performed XRF calibration and analysis techniques, sample preparation, data entry, confirmational sampling, and compiled daily XRF reports for the following projects:

Asarco Ruston Soils Project (MTCA/CERCLA), Ruston, Washington. This project consisted of remediation of soils containing high concentrations of metals at over 1,000 private residences in Ruston and North Tacoma, Washington. Affected public properties are contaminated with arsenic and other metals resulting from emissions from a former copper smelter.

Murray Pacific Logyard #1, Tacoma, Washington. This \$6 million project consisted of an industrial logsort yard site contaminated with arsenic, metals, and hydrocarbons and included soil cleanup to residential standards.

Asarco Glover Smelter Investigation, Glover, Missouri. This project involved an investigation to evaluate conditions in the vicinity of this lead smelter.

Tacoma Public Utilities, Tacoma, Washington. Performed XRF calibration and analysis techniques, sample preparation, data entry, confirmational sampling, and compiled XRF reports for this project.

PROFESSIONAL QUALIFICATIONS

GARTH B. BLOCK, E.I.T.

EXPERIENCE

GENERAL

Garth Block is in charge of Environmental Chemistry and Quality Control/Data Validation. He is an environmental scientist with 16 years of experience in providing guidance and ensuring compliance with federal and state regulations in the areas of environmental remediation, air quality and hazardous waste handling. Mr. Block has worked on components of environmental compliance at the Department of Energy's National Engineering Laboratory as well as at a lead smelter, a coal-fired electric power generating facility, and at a large fertilizer plant.

Mr. Block has worked on numerous remedial investigations, feasibility studies, and remedial design/remedial action projects from start to finish. His experience includes the preparation of investigative reports, developing sample and analysis plans, sample collection, site characterization, analytical interpretation, preparation of remedial designs, and the submittal of remedial action progress reports to the state and federal agencies.

EDUCATION

1976 B.S. Biology, Western Montana College, Dillon, Montana

EMPLOYMENT HISTORY

1990 to Present	Environmental Scientist, Hydrometrics, Inc., Helena, Montana
1990 to 1990	Senior Scientist, EG&G Idaho, Inc., Idaho Falls, Idaho
1986 to 1990	Environmental Quality Assurance Technician, Intermountain Power Service Corporation, Delta, Utah
1982 to 1986	Environmental Technician, Beker Industries, Soda Springs, Idaho

TRAINING

Environmental Regulations Course by Executive Enterprises
Radiation Safety Training Course by Texas Nuclear Corporation
CERCLA 40-Hour Training by Preferred Meeting Management
Visible Emission Reading by Utah Bureau of Air Quality
Effective Business Writing by Shipley Associates

OTHER EXPERIENCE

Taught math, biology and science at Beaverhead High School, Dillon, Montana (1981)
Camp Director BLM YCC summer camp, Dillon, Montana (1980)
Graduate Assistant, Western Montana College, Dillon, Montana (1978)

PROFESSIONAL LICENSES AND REGISTRATIONS

Engineer-in-Training, National Council of Engineering Examiners
Engineer, State of Utah Division of Occupational and Professional Licensing, Certificate #0911609990, 1989

RELEVANT PROJECTS

ENVIRONMENTAL ANALYSIS AND PERMITTING

Mr. Block provided guidance and support in the areas of air compliance and hazardous waste operations for the Department of Energy's Idaho National Engineering Laboratory; maintained an "L" security clearance; assisted management in the preparation and review of environmental reports, contingency plans and company procedures; did air permitting requested by the State of Idaho and for EPA Region X; and identified and interpreted applicable environmental regulations to assure regulatory compliance including reporting on renovation projects that included the removal of friable asbestos. He is knowledgeable on RCRA/CERCLA requirements.

He carried out meeting Utah Bureau of Air Quality and EPA compliance requirements for the Intermountain Generating Station, a 2-unit, 1600 megawatt coal-fired electric generating facility. He generated reports including excess emissions, quarterly compliance, relative accuracy, annual emissions, and SARA Title III reports; supervised quality control technicians in the operation and auditing of the continuous emissions monitoring system to ensure accuracy and reliability; worked with regulators and auditors from federal, state and local governments on environmental concerns and provided technical support for radiation exposure and hazardous material spill response.

His accomplishments at the power plant included: Development of a comprehensive management plan for achieving regulatory compliance including a 16-page footnoted document quoting state and federal regulations, conditions of the operating permit, regulatory expert interpretations and variances obtained to give management a guideline for meeting environmental requirements; formulated an emission testing program for the station; coordinated and supervised EPA reference method testing activities which also included conception, design, testing, implementation and final report writing (the annual emissions testing reports submitted to the State were 400+ pages); maintained a record of no "Notice of Violation" issued by the State on over 100 Upset Condition Reports filed since station start-up; developed rapport with state regulators allowing both state and station needs and concerns to be met and resolved and developed an engineering economic analysis plan for the justification of capital projects at the station.

Mr. Block's responsibilities at a phosphate fertilizer plant included: reporting emissions and conducting stack sampling at two sulfuric acid plants, a phosphoric acid plant, three calciners and a diammonium phosphate plant; maintaining a meteorological station, an ambient sulfur dioxide analyzer and several high volume monitors; and checking indicator parameters in a groundwater monitoring program.

ENVIRONMENTAL REMEDIATION

Mr. Block's consulting responsibilities include coordinating and administering CERCLA activities relating to an operating lead smelter; preparing design plans for the remediation of contaminated soil in residential areas and in several operable units at the smelter; and maintaining open communication between Hydrometrics, client, EPA, the State and a citizens' advisory committee. Mr. Block has also performed statistical analyses and graphics for soil and water investigations at municipal landfills and at lead, copper, and zinc smelters in Montana, Washington, Texas and Ohio.

ATTACHMENT II. EXAMPLE CHAIN-OF-CUSTODY FORM

2727 Airport Road • Helena, Montana 59601 • (406) 443-4150

[illegible]

ATTACHMENT III. XRF ANALYSIS STANDARD OPERATING PROCEDURE

XRF STANDARD OPERATING PROCEDURE

PREPARATION AND ANALYSIS OF SOIL SAMPLES

1.0 PURPOSE

This SOP outlines procedures for simultaneous elemental analysis by X-ray Fluorescence Spectrometry (XRF). A dried and ground sample of soil is bombarded with X-rays, causing elements in the sample to fluoresce. A lithium-doped silicon detector measures the quantity and energy of fluorescent radiation. The energy of the fluorescence is indicative of the originating element and the quantity is proportional to the elemental concentration.

2.0 METHOD DESCRIPTION

Soils are analyzed with the XRF through comparison of sample fluorescence (wavelength and energy) with the fluorescence exhibited by samples of known concentration. Typically one of two methods is used:

- **Fundamental Parameters:** Developed by the instrument manufacturer, the fundamental parameters method uses instrument software to mathematically produce theoretical standards to account for sample matrix variations, allowing for quantitative analysis with a minimum of standards. The method accounts for both matrix effects (increases in absorption with increasing average atomic number), and interelement effects (absorption or enhancement of photons emitted by one element by a different element). Coefficients are developed to quantitatively describe these effects on the fluorescence intensity of pure elements; these coefficients are then applied to results for unknown samples to calculate concentrations.
- **Site-Specific Calibration:** This method is similar to more traditional instrumental methods in that a calibration curve is developed using a number of samples of known concentration. The curve relates X-ray intensity to concentration, and is then used to quantify unknowns. In general, separate curves are necessary for different types of matrices (mineralogy), and each curve requires that a number of samples specific to the site be reanalyzed several times to determine the "known" or standardized concentration.

3.0 DETECTION LIMITS

For XRF work, the detection limit is three times the standard deviation of the background counts when measuring samples of known concentration. Typical detection limits for specific elements are shown in the attached Laboratory Analysis Plan, and range from 10 ppm (mg/kg) to 130 ppm, with most elements in the range from 10 to 30 ppm.

4.0 INTERFERENCE AND CORRECTIVE ACTIONS

Iinterelement effects are accounted for in the fundamental parameters method by a group of matrix correction software routines that contain the physical constants that have been tabulated describing X-ray absorption and emission phenomenon. Fundamental parameter routines also rely on the mathematical description of absorption and enhancement effects and the comparison nature of XRF analyses, i.e. comparing the response of the instrument

from a standard to an unknown. Interference due to moisture content of soil is eliminated because all soils are dried prior to analysis.

5.0 SAFETY PRECAUTIONS

When appropriate safety precautions are written into the actual procedures used in the laboratory, for example, the use of hoods and respirators. For more detailed information, a Chemical Hygiene Plan has been supplied to all laboratory workers. The Chemical Hygiene Plan addresses such items as radiation safety and monitoring by film badge of employees using XRF.

6.0 SAMPLE SIZE, COLLECTION, PRESERVATION, AND HANDLING

A minimum of 100 grams is required for XRF analysis. Samples are typically received in zip lock bags. Sample preservation is not required for measurement of total metals using XRF.

7.0 APPARATUS

Microwave or	Ziplock Bags (one gallon size)
Drying Oven	Kraft paper bags (100 g. size)
Shatter Box Grinder or	XRF Instrument
Mill Grinder	XRF Soil Cups
Mylar (4.5 mm)	

8.0 ROUTINE PREVENTATIVE MAINTENANCE

- a. Fill dewar tank with liquid nitrogen at the beginning of the day on Tuesdays and Fridays or twice a week. Safety glasses and autoclave gloves must be worn when filling. XRF should sit idle for approximately 20 minutes after filling. Check fast discriminator rate (direction preceding) to make sure it is within range before calibrating. Order liquid nitrogen from supplier every three weeks.
- b. Keep carousel area free of dust and dirt. Replace mylar on detector when dirty or severely scratched (must be visually inspected before attempting this procedure).
- c. Unplug computer and XRF during power surges such as electrical storms.
- d. Leave computer on in between sample runs. The XRF must be energy calibrated each time the computer is turned on.

9.0 REAGENT AND CALIBRATION STANDARDS

The fundamental parameters analysis technique is most accurate when samples and standards are of similar matrix. NIST soils are standards for XRF analyses. They are prepared as samples and are stored in air-tight XRF-cups. Remaining standard material is stored in a desiccator. Since XRF is non-destructive, the standards can be re-used indefinitely.

Calibration Standards for the Fundamental Parameters Method

Sample ID	K %	CA %	TI %	CR PPM	MN PPM	FE %	NI PPM	CU PPM	ZN PPM	AS PPM	PB PPM	HG PPM	AG PPM	CD PPM	BA PPM	SiO ₂ DIFF
2710	2.11	1.25	0.283	(39)	10110	3.38		2950	6952	626	5532	(32)	35	(22)	707	
2711	2.45	2.88	0.306	(47)	638	2.89		114	350	105	1162			42	726	
2704	2	2.6	0.457	135	555	4.11		99	438	(23)	161				414	
2709	2.03	1.89	0.342	130	538	3.5	88	35	106						968	
8408	(1.5)		(0.56)	(88)	(1400)	(2.6)			(160)		(80)	107			(360)	
8407	11.7)		(0.44)	(98)	(970)	(2.42)			(230)		(96)	50			(400)	

10.0 CALIBRATION PROCEDURES

- Equations for the fundamental parameters method of analysis have been obtained from from TN Spectrace, Inc., Fort Collins, Colorado. In the event site specific calibration is used, methods are outlined in the project work plan and/or QAPP.
- Energy calibration using a copper disk will be performed at the beginning of each working day.
- A check standard of known concentration will be run at the beginning of each working day. If that standard falls outside the QC limit ($\pm 25\%$), the instrument will be re-calibrated.

11.0 PROCEDURES FOR SAMPLE PREPARATION

- Receive sample (200-2000 grams).
- Record sample into laboratory log book and give sample laboratory and archive code. Mark sample bag with laboratory code.
- Dry sample by microwave or in drying oven if needed to achieve uniform split.
- Homogenize and split sample into 100 – 150 gram size using "cone and quartering method". Save one 100-150 gram section of sample, archive section(2) equaling at least 200 grams and discard remaining sample into contaminated waste container.

"Cone and Quartering Method"

- Place entire sample onto clean freezer paper.
- Roll sample back and forth using all sides of paper. This is to be done until aggregate size is uniformly distributed in a cone fashion.
- Sample is then divided into "pie" sections until sections equal 100-150g.
- Dry 100-150g sample section in microwave or drying oven until sample is friable.

- Disaggregate and screen sample using a decontaminated #10 stainless steel mesh screen. Disaggregation is accomplished by crushing sample with a ceramic or agate mortar and pestle prior to screening or a rubber pestle can be used to crush aggregates on screen taking care not to crush sample near soldered edges of screen. Discard over size sample into contaminated waste container. Screen is to be decontaminated by using compressed air in between each sample. The mortar and pestles will be decontaminated using compressed air, rinsed with distilled water and wiped dry.
- Grind undersize sample using shatterbox grinder for a period of 2 minutes (more may be required depending on matrix of sample) to achieve <100 mesh size. Three samples may be ground at the same time using a Spex 8510 model with adapter. Sample may also be ground using a mill type grinder for a period of 2 minutes or longer if required. Grinder is cleaned thoroughly by spraying with compressed air in between each sample. Mill grinder is additionally cleaned by grinding clean silica and spraying with compressed air. All grinding and decontaminating is to be done under a well ventilated hood. Canister type respirators are to be worn supplied with particulate HEPA filters when working with samples containing high concentrations of contaminants.
- Cool ground sample.
- Place »10g sample into XRF sample cup. Tamp sample to a consistent depth and density within the cup. Place Mylar on cup and anchor with a plastic ring. Mark cup with sample code. Remaining sample is to be placed into a kraft paper sample bag, marked with sample code and archived. After analyses, XRF sample cup is to be archived.

12.0 ANALYTICAL MEASUREMENT

a) Equipment

Spectrace 5000 Energy Dispersive X-Ray Fluorescence Spectrometer and computer with appropriate software. The Spectrane 5000 EDXRF includes the sample chamber subsystem, the X-ray excitation subsystem, and the X-ray detector subsystem.

The sample changer subsystem consists of the sample chamber and chamber lid assembly as well as the sample changer, six position filter wheel and ports for the X-ray tube and detector. The X-ray excitation subsystem includes the 30KV Rhodium tube and the X-ray high voltage power supply. The X-ray detector subsystem consists of a lithium drifted silicon detector, preamplifier, amplifier, analog-to-digital converter and data memory.

The Spectrace 5000 utilizes an IBM-compatible PC for overall control of the system including direct control of the subsystems in the 5000 system unit, data processing and information display.

b) Procedure

- 1) Unlock XRF at rear of instrument and turn on the computer.
- 2) Calibrate instrument to copper energy line by the following:
TYPE: C:\EDXRF
PRESS: <ENT> <F5>
TYPE: \??? - Name of the program containing the energy calibration setup.
PRESS: <ENT>
Place **copper disk** into **position #16** of carousel.
Enter into program containing calibration setup.
PRESS: <F7> <SPACEBAR>
- 3) Check system status display by the following:
TYPE: <F2> <F4>
Check "**Fast Disc Rate**" - this should be between 100 and 150/sec. If not, adjust the Fast Discriminator with a tool supplied by Spectrace to bring the rate into the correct range (**must be visually instructed before attempting with procedure**).
- 4) Print system status display by the following:
PRESS: <PRINT SCRIN>
PRESS: <F10> <F10>
- 5) Run intensity correction program by the following:
Put Intensity Correction sample into **position #1**.
Highlight **Procedure #8**.
PRESS: <F1> <ENT>
The report of the check standard factor will automatically print out. Record into daily calibration log book along with the: **gain dac, zero dac, fast discriminator (from system status hardcopy); date, time, initials of the analyst and whether the liquid nitrogen dewar tank was filled.**
- 6) Run quality control and unknown samples by the following:
Review quality control limits set for each project. These standards must be consistently followed in order for results to be considered "valid." The quality control limits are found in section 5 of this SOP.

View prepared sample in XRF cup. Check for even distribution of particles. If necessary, tap the cup until particles are distributed evenly. Place cup carefully into the carousel.

After XRF cups are appropriately placed in carousel:

PRESS: <F1>

TYPE: # - Number of samples to be run

PRESS: <ENT>

TYPE: ##-#### - Laboratory sample code

PRESS: <ENT>

After all lab codes are entered, recheck codes by:

PRESS: <F10>

Repeat above procedure by pressing <ENT> after each lab code is displayed correctly or edit lab codes when needed before pressing <ENT>

After all lab codes have been entered correctly, place carousel into the XRF by aligning pins with correct slots. Tighten thumb screw only slightly. Check all cups for proper placement. **Close lid carefully.** The energy level will increase and x-rays will engage at this point. When spectrum appears on screen, the analysis has begun.

If x-rays fail to engage:

Check front and back panel doors to ensure they have been properly latched. The latch for the front panel is located in the back of the XRF behind the back panel. This handle should point down. Turn the key to lock the back panel. Also, check the lid for proper latching. When lid is closed and program has started, a clicking sound can be heard (this is the latching of the lid). If no click is heard, push down slightly on lid and listen for a click. If lid again fails to latch, or if there are other problems, refer to the operator's manual or call Spectrace Instruments (415) 967-0350 and ask for a technician.

To stop the program at any time:

PRESS: <F10> This will also back out of each screen or menu.

If paper misfeeds:

Adjust printer and set "on line".

If printer error message displays on screen:

Type: <R> - Report will print from the point of interruption.

If data is unreadable:

Highlight the procedure the samples were run from.

PRESS: <F2> <F6> <F7> Entire report will print.

PRESS: <F10> <F10> This will put you back into main menu.

If program is disrupted during analyses:

=>If samples were run using a **single procedure**:

Check hard copy for last sample result and run samples with missing results.

=>If samples were run using a **combined procedure** (ex. 6+7 Unknown):

Highlight each **single procedure** comprising the combined procedure and follow proceeding instructions (ex. Highlight procedure 6 first to print out report, repeat for procedure 7 to print out report).

PRESS: <F2>

HIGHLIGHT: "SPECTRUM PROCESSING"

PRESS: <F1>

TYPE: ## - Number of samples that were run before disruption (if this is an unknown number, type in 16).

PRESS: <ENT> Wait until samples are processed.

HIGHLIGHT: "ANALYSES TECHNIQUE"

PRESS: <F1> Report will print out.

If screen displays error message "ZERO DAC AT LIMIT":

PRESS: <F7> <F4> <F10> <F10>

If spectrum displays on screen, reanalysis has begun. If not, use the procedure described in

"If program is disrupted during analyses:."

- 7) Copy project Results file to disk by the following:

Go to program directory prompt:

PRESS: <F10>

TYPE: Y

Copy ASCII Results file:

Insert disk in drive (B:)

TYPE: COPY RESULTS A: LL##### (Project, Year, Month, Day)

PRESS: <ENT>

ex) EH010831 (East Helena Project, 2001, August 31st)

To convert Results file to Lotus 123 (if needed):

PRESS: <F10>

TYPE: Y CONV123

PRESS: <ENT>

TYPE: N Y ??##### (Project, Year, Month, Day)

PRESS: <ENT>

To copy Lotus 123 file to disk:

TYPE: COPY ??#####.WKS A (or B drive):

- 8) Erase project Results (and Lotus 123) file by the following:

Go to program directory prompt:

PRESS: <F10>

TYPE: Y

Erase Results file:

TYPE: ERASE RESULTS

Erase Lotus 123 file:

TYPE: ERASE ??#####.WKS

13.0 DATA TREATMENT

Raw data in counts/minute are converted to parts per million (PPM) by the fundamental parameters program by comparing instrument response from the standards to the unknowns. The hardcopy results in ppm from the XRF instrument will be reviewed and filed. An electronic file of the results is transferred to the Archive database program for reporting and storage.

14.0 DATA DELIVERABLES

This procedure is used to review all analytical data generated by the Hydrometrics Soils Laboratory before the data is released to the client. It is the reviewer's and/or laboratory supervisor's responsibility to ensure that established quality control standards were met, transcription errors are corrected and proper documents are in order before the analytical data is released to the client.

- a) Load XRF with samples and enter sample names into the XRF program. Record analyst's initials onto hardcopy of XRF printout.
- b) After samples have been analyzed, review analytical results on XRF hardcopies for:
 - 1) Transcription errors. Draw single line through error, correct and sign with initials.
 - 2) Review quality control sample limits. Check and mark with an "OK" if sample values are within the project's quality control limits. If sample values are out of limits, check and mark with "OUT." Follow work plan's procedure for "out of limit" quality control samples.
 - 3) Review quality control sample frequency. Record on hardcopy if quality control sample frequency was not met. Follow project work plan's procedure for non-compliance of required quality control sample frequencies.
 - 4) Sign hardcopy and date.
 - 5) Record batch number onto hardcopy.
- c) Run data through Hydrometrics' "Archive" database program and print analytical and quality control reports.
- d) Review analytical and quality control reports for transcription errors and quality control sample limits and frequencies. Take appropriate steps to correct errors.

- e) If requested, copy results and quality control data onto computer disk using the appropriate data dump program from the "Archive" program. If Hydrometrics Validation Department is to validate the data, use the "Data Validation" data dump program.
- f) Compile analytical report with a cover letter, "EDXRF DOCUMENTATION," "EDXRF ANALYTICAL DATA" and "EDXRF QUALITY CONTROL" cover pages. State in letter or memo the date samples were received and analyses completed. Note any problems that occurred in preparation, analysis or reporting, if any.
 - 1) Address letter or memo to the project manager unless otherwise requested. Copy to the Hydrometrics Data Validation Department if data is to be validated or entered into the central data system. Refer letter or memo to appropriate project.
 - 2) Place copies of the chain of custodies, login pages and XRF hardcopies behind the EDXRF DOCUMENTATION" page. The appropriate copies of the daily log will also be included here.
 - 3) Place copies of analytical report behind the "EDXRF ANALYSES DATA" page. The data reviewer must sign his/her initials on this page. After entire data package is put together, it must be proved and signed by the laboratory supervisor or qualified person.
 - 4) Place copies of the quality control report behind the "EDXRF QUALITY CONTROL" page.
 - 5) If requested, place data computer disk with package.

15.0 QUALITY CONTROL REQUIREMENTS

- a) Accuracy Check
Laboratory Control Sample (LCS):
 - FREQUENCY:** AT BEGINNING OF WORKING DAY (PLACE IN #1)
 - ACTION:** RECALIBRATION AND RERUN
 - STANDARD:** LCS/NIST 2711
 - LIMITS:** Parameter specific: 75-125% recovery of certified value
- b) Calibration Check
Continuing Calibration Verification (CCV):
 - FREQUENCY:** 1/32 (PLACE IN #1 POSITION)
 - ACTION:** RERUN PREVIOUS 32 SAMPLES
 - STANDARD:** CCV/NIST 2711
 - LIMITS:** SAME AS ABOVE

- c) Precision Check
Laboratory Duplicate (D):
FREQUENCY: 1/16 (USE LAST SAMPLE OF PREVIOUS RUN AND
PLACE IN #1 OR #2 (WITH CCV) POSITION)
ACTION: FLAG ASSOCIATED SAMPLES WITH *OUT*
LIMITS: 35% RELATIVE PERCENT DIFFERENCE (RPD) FOR
>5 X PRDL; AND +/- 2 X PRDL FOR <5 X PRDL

16.0 REFERENCES

Analytical and sample preparation methods are based on recommendations from TN Spectrace, Inc., 2401 Research Blvd., Suite 206, Fort Collins, Colorado 80526.

17.0 METHOD VALIDATION

Validation is not conducted at the laboratory. A copy of the database is sent to the Hydrometrics Data Validation Department located in Helena, Montana. The database is then entered into the central data system. The Validation Department review the QC information and confirmation results.

Sparge Test Investigation

Three sparge test wells and six monitoring wells were installed as part of the sparging test. These wells were completed in the locations previously indicated in the April Monthly Report (Attachment 1, Figure 1). In general, the subsurface stratigraphy was found to consist of a sequence of silty sand and gravel to a depth of approximately 25 feet. From 25 feet to 40 feet, sandier layers were encountered at irregular intervals. The stratigraphy in this lower interval was variable from well to well. Water was typically encountered at a depth of approximately 32 feet. Preliminary testing of the air sparge system indicated that the wells were capable of receiving air at the desired flow rate of 5 to 10 cfm at relatively modest pressures (5 to 10 psi). A water level response was observed in all the sparge monitoring wells during preliminary start-up testing. Water levels stabilized after about 20 minutes of operation. Based on this response, the sparge system was set to cycle at 15 minute intervals to maximize dispersion of air in the groundwater system. The sparge test was started on May 23rd. On June 29, 2000 the air sparge cycling intervals were fine-tuned to evaluate whether shorter injection cycles would still maintain adequate dissolved oxygen levels while minimizing potential disturbances to the physical flow field.

On August 19, 2000 Asarco discontinued sparging at the initial test location and initiated testing at Sparge Well No. 3 located approximately 125 feet to the west of the initial test site. The purpose of additional sparge testing at this second location is to evaluate the effectiveness of arsenic removal in groundwaters with varying iron concentrations.

Preliminary analytical results from the first site indicate air sparging effectively increased dissolved oxygen concentrations and resulted in conversion of arsenic III to V to varying extents in all of the sparge monitoring wells. Changes in total arsenic concentrations were most prevalent where higher iron concentrations were present. Iron concentrations are significantly higher in groundwater at the second test site (approximately 12 mg/L). The initial data from the sparge well at this second site show a rapid reduction in iron concentrations accompanied by significant reductions in arsenic in the Sparge-3 well. Recent results are showing similar water quality trends at monitoring well DH-24, downgradient of Sparge-3. In the October 19th meeting with EPA, Asarco agreed to prepare a summary report by year-end describing the test methodology and results.

Miller, Robert

To: Linda Jacobson (E-mail); Denise Kirkpatrick (E-mail)
Cc: Nickel, Jon
Subject: XRF Information

I am sending by overnight mail XRF information. Most of this information is in the RFI work plan. I have sent supplemented this information with information on the new field model 700 series, which is available through the web.

Bob.

Pamela Nafsinger
Thermo Electron - Niton Analyzers
877-255-6943

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Tuesday, March 21, 2006 America Online: MLUrquhart

Subj: **RE: Niton Quotation**
Date: 1/31/2006 11:55:21 A.M. Pacific Standard Time
From: pam.nafsinger@thermo.com
To: MLUrquhart@aol.com

Sorry about the typo in the quotation, that's what happens sometimes after a long travel day. I have attached a revised copy of the quote, including extended warranty costs. The XLp 702 is configured with a Cd-109 isotope, whereas the XLt 792 is configured with a miniature x-ray tube. Although both configurations allow for the analysis of Pb and As, as you can see from the descriptions of the two units, there is a slight difference in the range of elements they can detect. The XLt is able to analyze for Cd, Sn, Sb and Ag in addition to the primary element suite configured in the XLp 702. The Cd-109 source has a half life of approximately 15 months, meaning it decays to half of its original strength over a 15 month period. Because it is originally sourced with a 40 mCi isotope, it will require replacement in approximately 4 years at a cost of \$6,500. The measurement time will automatically compensate (become longer) with the decay of the source. The x-ray tube in the XLt 792 also has a useful life depending upon the hours of usage, with four years as a general estimate of useful life. It will then need to be replaced at a cost of \$4,500. Although the x-ray tube will always provide faster measurement times, there is no warning when the tube is about to go out (think of a light bulb!).

I am at a conference all day, but you can try me on my cell phone with any further questions (541-480-4010) and I'll get back with you as soon as I can.

From: MLUrquhart@aol.com [mailto:MLUrquhart@aol.com]
Sent: Tuesday, January 31, 2006 8:11 AM
To: Nafsinger, Pamela J.
Cc: rradmrc@comcast.net
Subject: Re: Niton Quotation

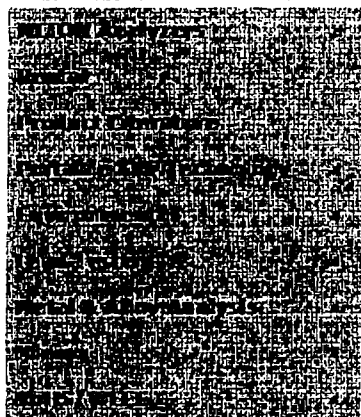
I am unclear on the differences between the xlp 702 and the xlt 792 a little explanation would help. Also your quote seems to have a typo, i.e. the xlp 702 is listed twice with a different price. What is the correct price for each unit.

Is a continuing maintenance agreement available? What does it cost and what is provided?

Please respond ASAP. Our final budget is due Wed morning.

Thank you,

Michael Urquhart
mlurquhart@aol.com
253-677-1415



NITON Analyzers Events

Radiation Safety Training

2/2/2006	Philadelphia, PA
2/3/2006	Baltimore, MD
2/8/2006	Milwaukee, WI
2/9/2006	Chicago, IL
2/23/2006	Pittsburgh, PA
2/28/2006	Bedford, MA

RoHS Webinar

2/23/2006	RoHS Compliance Webinar
2/23/2006	RoHS Compliance Webinar

Upcoming Tradeshows



ENVIRONMENTAL

In Situ Testing Using NITON's XRF Analyzers

In situ testing provides rapid, quantitative screening measurements to rapidly profile contaminant levels and determine remediation boundaries with surgical precision.

NITON XLI/XLp/XLt 700 Series multi-element analyzers are designed for both in situ and ex situ soil testing. Choose the analysis that best suits your applications and data quality objectives. For in situ analysis, place the XLI/XLp/XLt 700 Series directly on the ground, or test bagged soil samples. Since contamination patterns tend to be heterogeneous, the large number of data points produced using in situ testing typically provides a faster, more precise, and far more cost-effective way of delineating contamination patterns.

In situ testing with the XLI/XLp/XLt 700 Series is in full compliance with EPA Method 6200, Field Portable XRF Spectrometry for the Determination of Elemental Concentrations in Soils and Sediments. In situ testing lets you test many locations in a short time and is ideal for:

- Rapid site-profiling
- Locating sources of contamination
- Monitoring and fine-tuning remediation efforts on-the-spot

XLI/XLp/XLt 700 Series soil testing is non-destructive, so accredited laboratories can reanalyze all prepared samples to confirm results.

For in situ soil testing, the XLI/XLp/XLt 700 Series never needs site-specific calibrations. Sophisticated software corrects automatically for variations in soil-sample chemistry and density.

NITON Connects

LEADER IN PORTABLE XRF TECHNOLOGY • CASE STUDY • MAY 2000

Detecting Arsenic in Soil Using Field Portable X-Ray Fluorescence (XRF)

Current models of the NITON 700Series offer limits of detection of 15 ppm for As in soil, for testing times between 30–60 seconds.

Rapid Assessment of Arsenic

Rapid, accurate on site determination of arsenic and heavy metal levels in soil is a powerful tool in efforts to rebuild and revitalize abandoned and under-utilized industrial properties. The EPA is actively spearheading initiatives to encourage assessment, clean-up and re-use of these industrial properties. In the case of heavy metals (often the eight RCRA metals Pb, As, Cd, Cr, Hg, Ag, Ba, Se), the technology of choice is field portable x-ray fluorescence (XRF) analysis. NITON's field portable XRF offers a number of advantages for expediting site characterization and cleanup.

On-Site Investigations

Rapid, inexpensive site characterization methods for identifying priority pollutants in soil can be achieved. Field based XRF can be used *in situ* following EPA Method 6200. A large number of *in situ* tests

can be performed quickly, allowing for extensive geographic profiling which details metal contaminants and quantitates their levels. XRF is also non-destructive to the samples, allowing a sub-set to be sent for confirmatory laboratory analysis.

Remote Detection of Arsenic in Soil Practical Applications of the Field XRF Under Stringent Field Requirements

A large Canadian power company has been recently required to assess arsenic levels in soil around several of their facilities located throughout Canada. Because many of their facilities are in remote locations, laboratory turnaround times often take weeks. They plan to use NITON's portable XRF, with its innovative features, that provide rapid, quantitative results on-site in "real time."

The company requires a very accurate analysis of a limited number of samples at each site. For this reason, the appropriate testing method requires that samples be carefully prepared by sieving out the larger particles such as small rocks and organic matter, then grinding the remaining soil to an average particle size of 125 μm , producing a fine homogeneous powder. The powder will then be placed in special XRF sample cups prior to taking the reading. For many large site characterizations, the preferred method is to measure samples, *in situ*, or directly on the ground. This method is less accurate, but allows a very large area to be assessed and "screened"



The NITON XRF used *in situ*.

for contamination. In this case, however, accuracy is critical and therefore, correct sample preparation is essential.

Initial results for arsenic levels found using this method are shown in Figure 1. The correlation is outstanding, with an r^2 of 0.993. The limit of detection is 15 ppm after only 30 seconds of testing time, although longer testing times (2 minutes) are generally employed to obtain more precise results. Since most clearance levels for arsenic in the United States are less than or equal to 30 ppm, the NITON XRF is a reliable assessment tool to determine whether levels are below standard clean-up criteria.

Site Characterization Down Under

In an old industrial site in South-eastern Australia¹, a more traditional XRF testing protocol was required to assist with site characterization and remediation. The site is a large property with suspected wide-spread arsenic contamination. Project goals



The NITON XRF used at a remediation site.

Continued on page 2

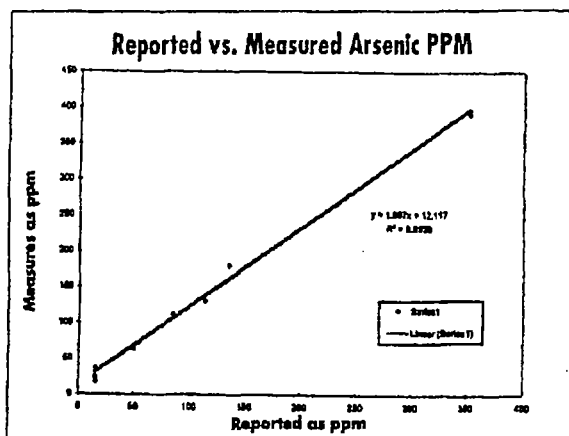


Figure 1. Comparison of reported arsenic ppm vs. measured arsenic ppm for the Canadian powerplant.

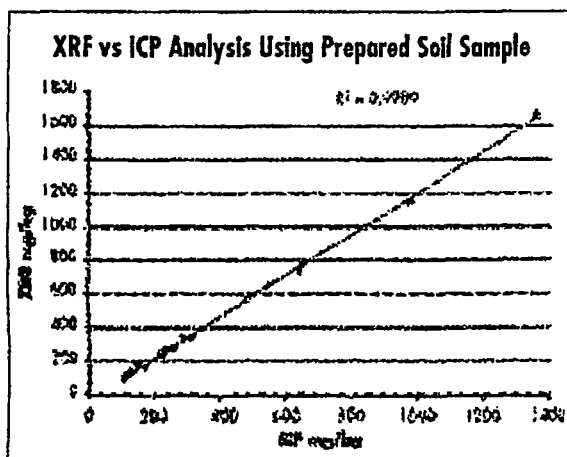


Figure 2. Comparison of NITON XRF results to laboratory results for arsenic in soil.

require a rapid assessment of the site to determine "hot spots" of arsenic, and expedite remediation. Remoteness of the site also makes extensive laboratory analysis both time consuming and expensive.

The NITON XRF is the perfect analytical tool to meet these demands. The XRF could be used for *in situ* testing, due to requirements of rapid site profiling and the need to quickly locate regions of high contamination. Operators will perform thousands of tests directly on the ground to thoroughly profile the arsenic contamination pattern. Several hot-spots will be mapped out, so remediation can begin immediately.

A limited number of samples were collected, homogenized and sieved to particle sizes < 250 μ , and

tested both by the NITON XRF and then sent for laboratory ICP analysis. Past work (shown in Figure 2) has demonstrated an excellent correlation between the field and laboratory results ($r^2 = 0.9989$).

The XRF is also a valuable tool during remediation efforts. For this site, remediation mainly consists of soil removal. A "dig and test" process will be employed to ensure that only contaminated soil is treated or removed, thus generating additional savings. Layers of soil will be removed and freshly exposed soil tested again with the NITON XRF, providing information on the depth of contamination. This allows the operator to stop digging when results are below action levels.

The use of portable XRF analysis for this site will assist in expediting site clearance and keeping analytical costs as low as possible. Site managers are able to eliminate the guesswork in determining if concentrations are below action levels. Samples pulled for final clearance are prepared and analyzed on site. If readings are near or exceed clearance levels remediation efforts will continued until on-site analysis indicates contaminant levels have met clearance criteria. This strategy reduces analytical costs, since only one set of clearance samples are sent for laboratory confirmation. Moreover, the likelihood of a failed clearance is virtually eliminated, thus reducing costly remobilizations of remediation crews for continued work if laboratory analysis indicates arsenic levels exceed action levels.

Summary

The two applications, presented above, for arsenic in soil testing using a NITON field portable XRF illustrate the versatility of this instrument. In one application, the customer requires that a limited number of samples be tested with a high degree of accuracy. For this case, samples are finely ground and placed in sample cups for testing. Results are obtained with testing

times of 20 to 30 seconds and a detection limit of 15 ppm. In the second application the customer requires that a very large number of samples be rapidly tested to profile the site and find "hot spots." In this case, a lower level of accuracy is acceptable and the customer chooses to perform rapid, in-situ tests followed by limited laboratory confirmation.

References

- 1 M. Ridings, A.J Shorter, CSIRO Tropical Agriculture, 306 Carmody Road, St. Lucia, Q4067, AUSTRALIA and J. Bawden-Smith, JBS Environmental Services & Technologies Pty Ltd, PO Box 1480 Bondi Junction, NSW 1355, Australia.



The NITON hand-held XRF.

NITON
LEADER IN PORTABLE XRF TECHNOLOGY

NITON Corporation
900 Middlesex Turnpike, Building 8
Billerica, MA 01821-3926

1-800-875-1578
Tel 978-670-7460
Fax 978-670-7430
xrf@niton.com
www.niton.com

For more information or a demonstration, please contact NITON at 800-875-1578

NITON Connects

LEADER IN PORTABLE XRF TECHNOLOGY • CASE STUDY • SEPTEMBER 1999

The Feasibility of Using the XRF for On-Site Measurement of Lead

New York State and NITON Corporation, an X-ray Fluorescence (XRF) manufacturer, led to the development of a protocol to assess lead levels in ambient air during the process of paint removal from bridges.

A revolutionary detector combined with a new procedure has made on-site detection of lead in ambient air a reality. A joint effort between John Zamurs¹ and his colleagues in New York State, and NITON Corporation, an X-ray Fluorescence (XRF) manufacturer, led to the development of a (novel) protocol to assess lead levels in ambient air during the process of paint removal from bridges. Lead based paints are routinely used on bridges because of their superior durability and adhesion properties. Periodically, however, bridges require re-painting and this involves the

removal of the old lead-based paint, typically using a technique called abrasive blasting. This process can expose workers to excessive levels of airborne lead particles and is a cause of widespread concern.

Abrasive blasting creates considerable dust, which is contained by placing an enclosure around the work site. The enclosures are made of tarpaulins or skirting material hung around the work area. This form of containment is often ineffective, with substantial variations from project to project, depending on the work practices of the group. Poor work practices or an insufficient enclosure can lead to a significant release of lead dust and particles into the surrounding environment. One such case of ineffective containment was reported during a paint removal project conducted on the Williamsburg Bridge in New York City in 1992.

Field Testing the XRF or XRF Field Performance

To address the need for a procedure to contain and monitor levels of lead dust and debris in the air, The New York State Department of ??? (NYSDOT) conducted a study using NITON's portable XRF. To evaluate the effectiveness of field-based XRF for real-time measurement of lead levels during abrasive removal projects, NYSDOT chose a painting project on the Conrail Bridge in New York.

The goal of the study was to investigate whether the NITON

XRF could provide accurate and timely information about on-site conditions. During the paint removal process, an artificial breach in containment was staged to see if the XRF would detect this break. XRF measurements, taken hourly, were made directly on the filter, which was mounted on the sampler. Only three measurements were made per filter due to limited access to the filter system. Triplicate measurements were averaged and adjusted for a determination of total TSP-lead on the filter. The amount of material removed by testing with the portable XRF unit was evaluated by wiping the XRF with a moistened Kim Wipe, which was tested later in an off-site laboratory by an Inductively Coupled Plasma and total digestion method. The results of the Kim Wipe analysis yielded less than 3 percent removal by testing with the portable XRF, which was considered insignificant.

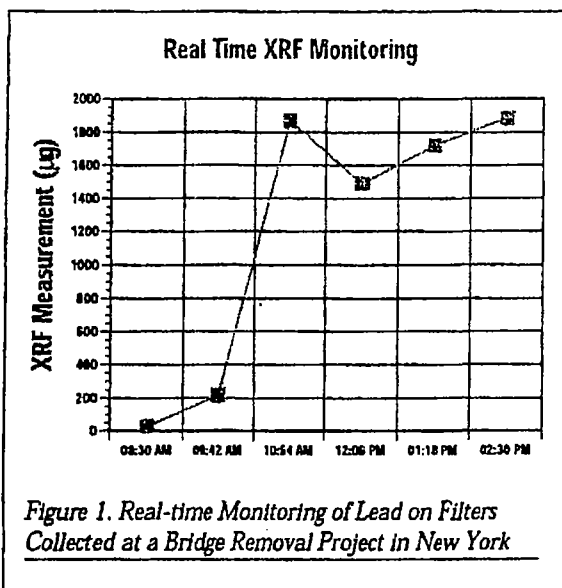
The results of this study showed that the NITON XRF could actually detect changes in lead levels on an hourly basis. Figure 2 illustrates the ability of XRF to give a true picture of the environment over time.

Figure 1 shows that a breach in containment occurred between 9:45 a.m. and 10:40 a.m., as evidenced by the sudden increase in lead levels. This figure also shows that containment of the breach was effectively performed, as seen by the sudden decrease in



Caption here

Continued on page 2



The results of the NYSDOT evaluation and resultant field protocol using NITON's portable XRF show that this technology can be effectively used for real-time measurements.

TSP-lead on the filter. The analysis conducted on-site correlated very well with off-site analysis. All measurements were within 7 percent of the total measurement for the filter using ICP analysis. The comparison of the XRF measurements to ICP gave a r^2 of 0.95, which indicated good correlation

NYSDOT Protocol for Monitoring Air Borne Lead via XRF

As a result of this study, the following protocol was developed

and is currently under consideration for complete incorporation into all paint removal projects that involve lead paint in New York State:

- The downwind station should be identified at the beginning of each day that abrasive blasting is to occur.
- The XRF instrument should be calibrated at the frequency specified by the manufacturer.
- Measurements of the filter should occur in three separate areas of the sample filter, with a 2 minute per reading minimum.
- The results of the triplicate readings should be recorded and averaged to obtain a reading in mg/cm^2 for the filter. The high volume flow rate should also be recorded in ft^3/min .
- The XRF should be cleaned with a Kim Wipe moistened with deionized water prior to each triplicate measurement.
- The average XRF measurement and the flow rate should be evaluated using the confidence limits defined by the field study to evaluate whether air quality effects are of concern.
- The information, XRF readings, flow rate data, date and time should be recorded in field books. If "concern" or "immediate action" limits are exceeded the appropriate project personnel should be notified immediately.

Conclusion

The results of the NYSDOT evaluation and resultant field protocol using NITON's portable XRF show that this technology can be effectively used for real-time measurements. NYSDOT is currently considering full implementation of the XRF real-time protocol in their monitoring program for bridge painting.

¹ Zamurs, J. Bass, B. Williams, R. Fritsch, D. Sackett, and R. Heman; "Real-Time Measurement of Lead in Ambient Air During Bridge Paint Removal", *Transportation Research Record*, 1998, No. 1641, pp. 29.



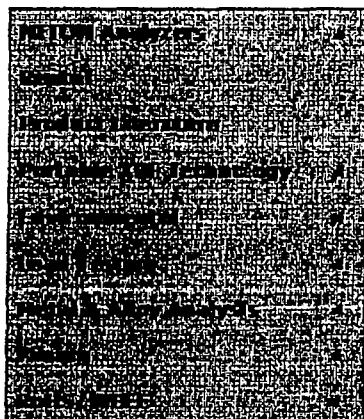
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Leaders in Portable XRF Technology

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www.niton.com

For more information or a demonstration please contact:
NITON at 800-875-1578



NITON Analyzers Events

Radiation Safety Training

2/2/2006	Philadelphia, PA
2/3/2006	Baltimore, MD
2/8/2006	Milwaukee, WI
2/9/2006	Chicago, IL
2/23/2006	Pittsburgh, PA
2/28/2006	Bedford, MA

RoHS Webinar

2/23/2006	RoHS Compliance Webinar
2/23/2006	RoHS Compliance Webinar

Upcoming Tradeshows



NITON Analyzers Rental Information

Thermo Electron provides direct rental of NITON Analyzers in the USA. The rental period is for one week, with discounted rates for periods of one month or more. We also allow customers to build equity in their rental by applying up to 90% towards the direct purchase of an instrument. Instrument leases are also available, providing customers with alternative financing options as their needs show.

For more information please contact:

niton.rental@thermo.com



Dear Customer:

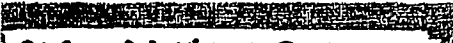
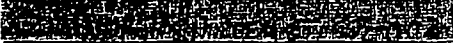

Thank you for your interest in one of Thermo Electron Corporation's NITON Analyzers. Before processing your order for a NITON Analyzer under the provisions of a General License, our Distribution License dictates that we provide you with a copy of certain regulations that will govern your use of the device. It is important that you review these regulations before making a final decision to process the order.

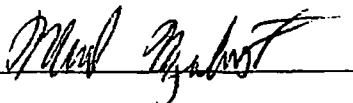
Attached you will find a notification from Thermo Electron describing some of the basic requirements and also copies of the regulations that address general licensing. Please review the attached notice and regulations and fill out the form at the bottom half of this letter acknowledging receipt of this information and confirming your order; it should be emailed to niton@thermo.com or faxed to 978-215-6123.


I , of , have
PRINT NAME NAME OF COMPANY OR ORGANIZATION

received a notification from Thermo Electron Corporation's NITON Analyzer business unit describing the basic requirements of a general licensee and including copies of 10 CFR 31.2, 31.5, 20.2202, 20.2201, and 30.51. I have reviewed this information and I authorize delivery of this device at the following address under the provisions of a general license.

Address:


MRC CONSTRUCTION LLC



Signature: 

Date: 

FREQUENTLY ASKED QUESTIONS ABOUT THE GENERAL LICENSE

NITON Analyzers' portable XRF devices can be purchased, rented, leased and operated under the provisions of a general license. The following are answers to some commonly asked questions about a general license.

How do I get a copy of my general license?

The general license is effective without filing an application with your regulatory agency or their issuance of any licensing document. You become a licensee the day you take delivery of your portable XRF device. There may, however, be a registration requirement that involves a registration application and a registration document.

Where do I find the regulations I must follow?

General licensees using portable XRF analyzers are subject to the requirements of 10 CFR 31.5 or the equivalent agreement state regulations. A copy of these requirements are attached.

Who regulates the use of the device?

The Nuclear Regulatory Commission (NRC) if you are in a "non-agreement state". The non-agreement states are: AK, CT, DE, DC, HI, ID, IN, MI, MO, MT, NJ PA, VA, VT, WV, and WY. In the NRC agreement states (i.e., those not listed above as non-agreement states), there is a state agency acting on behalf of the NRC as regulator. You can find contact information for your agreement state regulator at <http://www.hsrd.ornl.gov/nrc/rulemaking.htm>.

Where can I use my generally licensed NITON Analyzer XRF device?

In most states, a general license allows the NITON Analyzer device to be transported about and operated at any location within the provisions of other applicable laws and regulations. The device can even be brought into other states provided that you first meet the regulatory requirements of the local state regulator. It is always recommended that you notify the governing regulatory authority before bringing a generally licensed device into a state.

In some states, your general license only allows you to store and use the device at a single address. States that restrict use of generally licensed devices to a single location or address include Alabama, Georgia, Massachusetts, Nebraska, and Wisconsin.

A few states do not allow a portable device of any sort to be generally licensed. One must apply for (or have) a specific license to operate in these states: Kansas, Louisiana, Maryland, North Carolina, North Dakota, New Hampshire, New York, Ohio, and Oregon.

Am I required to register the device?

A registration will always be required for devices with more than 1 millicurie of Americium 241 (Am-241). In agreement states, other registrations may apply.

For more information about US licensing, visit www.niton.com/USLicensing.asp



Notice To Customers Purchasing A NITON XRF Analyzer Under The Provisions Of A General License

Subject: Responsibilities Associated With Possession and Use of NITON XRF Analyzers Under the Provisions of a General License

In accordance with 10 CFR 32.51A(4) & (5), Thermo Electron Corporation's NITON Analyzers business unit will provide disposal of all radioactive sources contained in NITON analyzers. Thermo Electron's NITON Analyzers provides disposal of radioactive sources for both re-sourcing and final XRF instrument decommissioning. Customers are asked to return their instrument to us for this disposal.

It is the policy of the U.S. Nuclear Regulatory Commission (USNRC) and States signed into agreement with the USNRC to issue high civil penalties to persons who improperly dispose of radioactive material.

Thermo Electron Corporation has provided a copy of the pertinent regulations from the USNRC. Please check with your State Radiation Control Program (<http://www.hsrdo.ornl.gov/nrc/asdirectr.htm>) for State specific information regarding General Licensing requirements. Regulations describing the NRC requirements include:

- 10 CFR 31.2, Terms and conditions
- 10 CFR 31.5, Certain detecting, measuring, gauging, or controlling devices and certain devices for producing light or an ionized atmosphere (**Your Primary License Requirements**)
- 10 CFR 20.2202, Notification of incidents
- 10 CFR 20.2201, Reports of theft or loss of licensed material
- 10 CFR 30.51, Records

Please be advised that other regulations may apply including those of the department of transportation. Please keep in mind that certain activities related to possession of radioactive materials should only be conducted by licensed individuals. These activities include:

- Leak test analysis
- Disposal of radioactive material
- Service of portable devices
- Resale of portable devices
- Decommissioning of portable devices

Please contact me toll-free at 800-875-1578 or Jim.Blute@thermo.com for further questions related to the contents of this package.

Sincerely,
James Blute, CHP
Radiation Safety Officer

§31.2 Terms and conditions.

The general licenses provided in this part are subject to the general provisions of Part 30 of this chapter (Secs. 30.1 through 30.10), the provisions of Secs. 30.14(d), 30.34(a) to (e), 30.41, 30.50 to 30.53, 30.61 to 30.63, and Parts 19, 20, and 21, of this chapter¹ unless indicated otherwise in the specific provision of the general license.

¹ Attention is directed particularly to the provisions of Part 20 of this chapter concerning labeling of containers.

§31.5 Certain detecting, measuring, gauging, or controlling devices and certain devices for producing light or an ionized atmosphere.⁽²⁾

(a) A general license is hereby issued to commercial and industrial firms and research, educational and medical institutions, individuals in the conduct of their business, and Federal, State or local government agencies to acquire, receive, possess, use or transfer, in accordance with the provisions of paragraphs (b), (c) and (d) of this section, byproduct material contained in devices designed and manufactured for the purpose of detecting, measuring, gauging or controlling thickness, density, level, interface location, radiation, leakage, or qualitative or quantitative chemical composition, or for producing light or an ionized atmosphere.

(b)(1) The general license in paragraph (a) of this section applies only to byproduct material contained in devices which have been manufactured or initially transferred and labeled in accordance with the specifications contained in—

- (i) A specific license issued under Sec. 32.51 of this chapter; or
- (ii) An equivalent specific license issued by an Agreement State.

(2) The devices must have been received from one of the specific licensees described in paragraph (b)(1) of this section or through a transfer made under paragraph (c)(9) of this section.

(c) Any person who acquires, receives, possesses, uses or transfers byproduct material in a device pursuant to the general license in paragraph (a) of this section:

(1) Shall assure that all labels affixed to the device at the time of receipt and bearing a statement that removal of the label is prohibited are maintained thereon and shall comply with all instructions and precautions provided by such labels;

(2) Shall assure that the device is tested for leakage of radioactive material and proper operation of the on-off mechanism and indicator, if any, at no longer than six-month intervals or at such other intervals as are specified in the label; however:

- (i) Devices containing only krypton need not be tested for leakage of radioactive material, and
- (ii) Devices containing only tritium or not more than 100 microcuries of other beta and/or gamma emitting material or 10 microcuries of alpha emitting material and devices held in storage in the original shipping container prior to initial installation need not be tested for any purpose;

(3) Shall assure that the tests required by paragraph (c)(2) of this section and other testing, installation, servicing, and removal from installation involving the radioactive materials, its shielding or containment, are performed:

- (i) In accordance with the instructions provided by the labels; or
- (ii) By a person holding a specific license pursuant to parts 30 and 32 of this chapter or from an Agreement State to perform such activities;

(4) Shall maintain records showing compliance with the requirements of paragraphs (c)(2) and (c)(3) of this section. The records must show the results of tests. The records also must show the dates of performance of, and the names of persons performing, testing, installing, servicing, and removing from the installation radioactive material and its shielding or containment. The licensee shall retain these records as follows:

(i) Each record of a test for leakage or radioactive material required by paragraph (c)(2) of this section must be retained for three years after the next required leak test is performed or until the sealed source is transferred or disposed of.

(ii) Each record of a test of the on-off mechanism and indicator required by paragraph (c)(2) of this section must be retained for three years after the next required test of the on-off mechanism and indicator is performed or until the sealed source is transferred or disposed of.

(iii) Each record that is required by paragraph (c)(3) of this section must be retained for three years from the date of the recorded event or until the device is transferred or disposed of.

(5) Shall immediately suspend operation of the device if there is a failure of, or damage to, or any indication of a possible failure of or damage to, the shielding of the radioactive material or the on-off mechanism or indicator, or upon the detection of 185 becquerel (0.005 microcurie) or more removable radioactive material. The device may not be operated until it has been repaired by the manufacturer or other person holding a specific license to repair such devices that was issued under parts 30 and 32 of this chapter or by an Agreement State. The device and any radioactive material from the device may only be disposed of by transfer to a person authorized by a specific license to receive the byproduct material in the device or as otherwise approved by the Commission. A report containing a brief description of the event and the remedial action taken; and, in the case of detection of 0.005 microcurie or more removable radioactive material or

failure of or damage to a source likely to result in contamination of the premises or the environs, a plan for ensuring that the premises and environs are acceptable for unrestricted use, must be furnished to the Director of Nuclear Material Safety and Safeguards, ATTN: GLTS, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001 within 30 days. Under these circumstances, the criteria set out in Sec. 20.1402, "Radiological criteria for unrestricted use," may be applicable, as determined by the Commission on a case-by-case basis;

(6) Shall not abandon the device containing byproduct material;

(7) Shall not export the device containing byproduct material except in accordance with part 110 of this chapter;

(8)(i) Shall transfer or dispose of the device containing byproduct material only by export as provided by paragraph (c)(7) of this section, by transfer to another general licensee as authorized in paragraph (c)(9) of this section, or to a person authorized to receive the device by a specific license issued under parts 30 and 32 of this chapter, or part 30 of this chapter that authorizes waste collection, or equivalent regulations of an Agreement State, or as otherwise approved under paragraph (c)(8)(iii) of this section.

(ii) Shall furnish a report to the Director of Nuclear Material Safety and Safeguards, ATTN: GLTS, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001 within 30 days after the transfer of a device to a specific licensee or export. The report must contain—

(A) The identification of the device by manufacturer's (or initial transferor's) name, model number, and serial number;

(B) The name, address, and license number of the person receiving the device (license number not applicable if exported); and

(C) The date of the transfer.

(iii) Shall obtain written NRC approval before transferring the device to any other specific licensee not specifically identified in paragraph (c)(8)(i) of this section.

(9) Shall transfer the device to another general licensee only if—

(i) The device remains in use at a particular location. In this case, the transferor shall give the transferee a copy of this section, a copy of Secs. 31.2, 30.51, 20.2201, and 20.2202 of this chapter, and any safety documents identified in the label of the device. Within 30 days of the transfer, the transferor shall report to the Director of Nuclear Material Safety and Safeguards, ATTN: GLTS, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001—

(A) The manufacturer's (or initial transferor's) name;

(B) The model number and the serial number of the device transferred;

(C) The transferee's name and mailing address for the location of use; and

(D) The name, title, and phone number of the responsible individual identified by the transferee in accordance with paragraph (c)(12) of this section to have knowledge of and authority to take actions to ensure compliance with the appropriate regulations and requirements; or

(ii) The device is held in storage by an intermediate person in the original shipping container at its intended location of use prior to initial use by a general licensee.

(10) Shall comply with the provisions of §§20.2201, and 20.2202 of this chapter for reporting radiation incidents, theft or loss of licensed material, but shall be exempt from the other requirements of parts 19, 20, and 21, of this chapter.

(11) Shall respond to written requests from the Nuclear Regulatory Commission to provide information relating to the general license within 30 calendar days of the date of the request, or other time specified in the request. If the general licensee cannot provide the requested information within the allotted time, it shall, within that same time period, request a longer period to supply the information by submitting a letter to the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001 and provide written justification as to why it cannot comply.

(12) Shall appoint an individual responsible for having knowledge of the appropriate regulations and requirements and the authority for taking required actions to comply with appropriate regulations and requirements. The general licensee, through this individual, shall ensure the day-to-day compliance with appropriate regulations and requirements. This appointment does not relieve the general licensee of any of its responsibility in this regard.

(13)(i) Shall register, in accordance with paragraphs (c)(13)(ii) and (iii) of this section, devices containing at least 370 MBq (10 mCi) of cesium-137, 3.7 MBq (0.1 mCi) of strontium-90, 37 MBq (1 mCi) of cobalt-60, or 37 MBq (1 mCi) of americium-241 or any other transuranic (i.e., element with atomic number greater than uranium (92)), based on the activity indicated on the label. Each address for a location of use, as described

under paragraph (c)(13)(iii)(D) of this section, represents a separate general licensee and requires a separate registration and fee.

(ii) If in possession of a device meeting the criteria of paragraph (c)(13)(i) of this section, shall register these devices annually with the Commission and shall pay the fee required by Sec. 170.31 of this chapter. Registration must be done by verifying, correcting, and/or adding to the information provided in a request for registration received from the Commission. The registration information must be submitted to the NRC within 30 days of the date of the request for registration or as otherwise indicated in the request. In addition, a general licensee holding devices meeting the criteria of paragraph (c)(13)(i) of this section is subject to the bankruptcy notification requirement in Sec. 30.34(h) of this chapter.

(iii) In registering devices, the general licensee shall furnish the following information and any other information specifically requested by the Commission--

(A) Name and mailing address of the general licensee.

(B) Information about each device: the manufacturer (or initial transferor), model number, serial number, the radioisotope and activity (as indicated on the label).

(C) Name, title, and telephone number of the responsible person designated as a representative of the general licensee under paragraph (c)(12) of this section.

(D) Address or location at which the device(s) are used and/or stored. For portable devices, the address of the primary place of storage.

(E) Certification by the responsible representative of the general licensee that the information concerning the device(s) has been verified through a physical inventory and checking of label information.

(F) Certification by the responsible representative of the general licensee that they are aware of the requirements of the general license.

(iv) Persons generally licensed by an Agreement State with respect to devices meeting the criteria in paragraph (c)(13)(i) of this section are not subject to registration requirements if the devices are used in areas subject to NRC jurisdiction for a period less than 180 days in any calendar year. The Commission will not request registration information from such licensees.

(14) Shall report changes to the mailing address for the location of use (including change in name of general licensee) to the Director of Nuclear Material Safety and Safeguards, ATTN: GLTS, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001 within 30 days of the effective date of the change. For a portable device, a report of address change is only required for a change in the device's primary place of storage.

(15) May not hold devices that are not in use for longer than 2 years. If devices with shutters are not being used, the shutter must be locked in the closed position. The testing required by paragraph (c)(2) of this section need not be performed during the period of storage only. However, when devices are put back into service or transferred to another person, and have not been tested within the required test interval, they must be tested for leakage before use or transfer and the shutter tested before use. Devices kept in standby for future use are excluded from the two-year time limit if the general licensee performs quarterly physical inventories of these devices while they are in standby.

(d) The general license in paragraph (a) of this section does not authorize the manufacture or import of devices containing byproduct material.

² Persons possessing byproduct material in devices under a general license in Sec. 31.5 before January 15, 1975, may continue to possess, use, or transfer that material in accordance with the labeling requirements of Sec. 31.5 in effect on January 14, 1975.

§20.2201 Reports of theft or loss of licensed material.

- (a) Telephone reports. (1) Each licensee shall report by telephone as follows:
- (i) Immediately after its occurrence becomes known to the licensee, any lost, stolen, or missing licensed material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in appendix C to part 20 under such circumstances that it appears to the licensee that an exposure could result to persons in unrestricted areas; or
 - (ii) Within 30 days after the occurrence of any lost, stolen, or missing licensed material becomes known to the licensee, all licensed material in a quantity greater than 10 times the quantity specified in appendix C to part 20 that is still missing at this time.
- (2) Reports must be made as follows:
- (i) Licensees having an installed Emergency Notification System shall make the reports to the NRC Operations Center in accordance with §50.72 of this chapter, and
 - (ii) All other licensees shall make reports by telephone to the NRC Operations Center (301)-816-5100.
- (b) *Written reports.* (1) Each licensee required to make a report under paragraph (a) of this section shall, within 30 days after making the telephone report, make a written report setting forth the following information:
- (i) A description of the licensed material involved, including kind, quantity, and chemical and physical form; and
 - (ii) A description of the circumstances under which the loss or theft occurred; and
 - (iii) A statement of disposition, or probable disposition, of the licensed material involved; and
 - (iv) Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas; and
 - (v) Actions that have been taken, or will be taken, to recover the material; and
 - (vi) Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed material.
- (2) Reports must be made as follows:
- (i) For holders of an operating license for a nuclear power plant, the events included in paragraph (b) of this section must be reported in accordance with the procedures described in §50.73(b), (c), (d), (e), and (g) of this chapter and must include the information required in paragraph (b)(1) of this section, and
 - (ii) All other licensees shall make reports to the Administrator of the appropriate NRC Regional Office listed in appendix D to part 20.
- (c) A duplicate report is not required under paragraph (b) of this section if the licensee is also required to submit a report pursuant to §§30.55(c), 40.64(c), 50.72, 50.73, 70.52, 73.27(b), 73.67(e)(3)(vii), 73.67(g)(3)(iii), 73.71, or §150.19(c) of this chapter.
- (d) Subsequent to filing the written report, the licensee shall also report any additional substantive information on the loss or theft within 30 days after the licensee learns of such information.
- (e) The licensee shall prepare any report filed with the Commission pursuant to this section so that names of individuals who may have received exposure to radiation are stated in a separate and detachable part of the report.

[56 FR 23406, May 21, 1991, as amended at 58 FR 69220, Dec. 30, 1993; 60 FR 20186, Apr. 25, 1995]

§20.2202 Notification of incidents.

(a) Immediate notification. Notwithstanding any other requirements for notification, each licensee shall immediately report any event involving byproduct, source, or special nuclear material possessed by the licensee that may have caused or threatens to cause any of the following conditions –

(1) An individual to receive –

(i) A total effective dose equivalent of 25 rems (0.25 Sv) or more; or

(ii) A lens dose equivalent of 75 rems (0.75 Sv) or more; or

(iii) A shallow-dose equivalent to the skin or extremities of 250 rads (2.5 Gy) or more; or

(2) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures).

(b) Twenty-four hour notification. Each licensee shall, within 24 hours of discovery of the event, report any event involving loss of control of licensed material possessed by the licensee that may have caused, or threatens to cause, any of the following conditions:

(1) An individual to receive, in a period of 24 hours –

(i) A total effective dose equivalent exceeding 5 rems (0.05 Sv); or

(ii) A lens dose equivalent exceeding 15 rems (0.15 Sv); or

(iii) A shallow-dose equivalent to the skin or extremities exceeding 50 rems (0.5 Sv); or

(2) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures).

(c) The licensee shall prepare any report filed with the Commission pursuant to this section so that names of individuals who have received exposure to radiation or radioactive material are stated in a separate and detachable part of the report.

(d) Reports made by licensees in response to the requirements of this section must be made as follows:

(1) Licensees having an Installed Emergency Notification System shall make the reports required by paragraphs (a) and (b) of this section to the NRC Operations Center in accordance with 10 CFR 50.72; and

(2) All other licensees shall make the reports required by paragraphs (a) and (b) of this section by telephone to the NRC Operations Center (301) 816-5100.

(e) The provisions of this section do not include doses that result from planned special exposures, that are within the limits for planned special exposures, and that are reported under §20.2204.

[56 FR 23406, May 21, 1991, as amended at 56 FR 40766, Aug. 16, 1991; 57 FR 57879, Dec. 8, 1992; 59 FR 14086, Mar. 25, 1994]

§30.51 Records.

(a) Each person who receives byproduct material pursuant to a license issued pursuant to the regulations in this part and parts 31 through 36 of this chapter shall keep records showing the receipt, transfer, and disposal of the byproduct material as follows:

(1) The licensee shall retain each record of receipt of byproduct material as long as the material is possessed and for three years following transfer or disposal of the material.

(2) The licensee who transferred the material shall retain each record of transfer for three years after each transfer unless a specific requirement in another part of the regulations in this chapter dictates otherwise.

(3) The licensee who disposed of the material shall retain each record of disposal of byproduct material until the Commission terminates each license that authorizes disposal of the material.

(b) The licensee shall retain each record that is required by the regulations in this part and parts 31 through 36 of this chapter or by license condition for the period specified by the appropriate regulation or license condition. If a retention period is not otherwise specified by regulation or license condition, the record must be retained until the Commission terminates each license that authorizes the activity that is subject to the recordkeeping requirement.

(c)(1) Records which must be maintained pursuant to this part and parts 31 through 36 of this chapter may be the original or a reproduced copy or microform if such reproduced copy or microform is duly authenticated by authorized personnel and the microform is capable of producing a clear and legible copy after storage for the period specified by Commission regulations. The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Records such as letters, drawings, specifications, must include all pertinent information such as stamps, initials, and signatures. The licensee shall maintain adequate safeguards against tampering with and loss of records.

(2) If there is a conflict between the Commission's regulations in this part and parts 31 through 36 and 39 of this chapter, license condition, or other written Commission approval or authorization pertaining to the retention period for the same type of record, the retention period specified in the regulations in this part and parts 31 through 36 and 39 of this chapter for such records shall apply unless the Commission, pursuant to §30.11, has granted a specific exemption from the record retention requirements specified in the regulations in this part or parts 31 through 36 and 39 of this chapter.

(d) Prior to license termination, each licensee authorized to possess radioactive material with a half-life greater than 120 days, in an unsealed form, shall forward the following records to the appropriate NRC Regional Office:

(1) Records of disposal of licensed material made under §§20.2002 (including burials authorized before January 28, 1981¹), 20.2003, 20.2004, 20.2005; and

(2) Records required by §20.2103(b)(4).

(e) If licensed activities are transferred or assigned in accordance with §30.34(b), each licensee authorized to possess radioactive material, with a half-life greater than 120 days, in an unsealed form, shall transfer the following records to the new licensee and the new licensee will be responsible for maintaining these records until the license is terminated:

(1) Records of disposal of licensed material made under §§20.2002 (including burials authorized before January 28, 1981), 20.2003, 20.2004, 20.2005; and

(2) Records required by §20.2103(b)(4).

(f) Prior to license termination, each licensee shall forward the records required by §30.35(g) to the appropriate NRC Regional Office.

[41 FR 18301, May 5, 1976, as amended at 43 FR 6922, Feb. 17, 1978; 52 FR 8241, Mar. 17, 1987; 53 FR 19245, May 27, 1988; 58 FR 7736, Feb. 9, 1993; 61 FR 24673, May, 16, 1996]

¹ A previous §20.304 permitted burial of small quantities of licensed materials in soil before January 28, 1981, without specific Commission authorization. See §20.304 contained in the 10 CFR, parts 0 to 199, edition revised as of January 1, 1981.

Subj: **General License**
Date: 3/29/2006 8:48:56 A.M. Pacific Standard Time
From: kim.masson@thermo.com
To: mlurquhart@aol.com

Good Morning Michael,

I am processing your order and will need a signed General License in order for us to ship your unit.

If you could please sign and return the top sheet to my fax# below or scan and send to my email I would appreciate it.

Thank you so much,

Kim

Kim Masson

Thermo Electron Corporation
NITON Analyzers
900 Middlesex Turnpike, Bldg. 8
Billerica, MA 01821 USA
Tel. 978-670-7460 Ext . 323
Fax 978-215-6123
email: kim.masson@thermo.com

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XLt



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NITON
THE LEADER IN PORTABLE XRF TECHNOLOGY

Weight	XLI 1.7 lbs (0.8 kg) XLt 3.0 lbs (1.4 kg)
Dimensions	XLI 11.5 x 3.5 x 3.0 inches (292 x 89 x 76 mm) XLt 9.75 x 10.5 x 3.75 inches (248 x 273 x 95 mm)
Excitation Source	XLI <i>Primary</i> ²⁴¹ Am Maximum 30mCi (1,110 MBq) – Infiniton, or ¹⁰⁹ Cd Maximum 40mCi (1,480 MBq) <i>Secondary</i> ²⁴¹ Am Maximum 14mCi (520 MBq) and/or ⁵⁵ Fe Maximum 20mCi (740 MBq) XLt Miniature x-ray tube and power supply (40kV/50uA maximum)
X-ray Detector	High-performance Si-PIN detector, Peltier cooled.
System Electronics	Hitachi SH-4 CPU ASICS high-speed DSP 4096 channel MCA
Batteries	(2) Rechargeable Lithium-Ion battery packs with Quick-swap capability. 6–12 hour (maximum depends on platform and duty cycle), 2 hour recharge cycle.
Display	1/4 Backlit VGA touch screen LCD
Analysis Range	Up to 25 Standard elements in the range Ti(22) to Pu(94) Some Nonstandard in-range elements available at additional cost.
Testing Modes	Bulk Sample Mode Thin Sample Mode, including Dust Wipe mode, 37mm Filter mode, User-Defined Thin Sample mode
Data Storage	Internal: 3000 readings with x-ray spectra (maximum)
Standard Accessories	Soil Sampling Kit/Thin Sample Kit (varies by model and configuration) Lockable, shielded waterproof carrying case Shielded belt holster Spare lithium-Ion battery pack with holster 110/220 VAC battery charger/adaptor PC interface cable NDT® (NITON Data Transfer) PC software Safety Lanyard Check/verification standards Integrated barcode scan engine for rapid/reliable entry of sample information
Training	U.S. – Call 1-800-875-1578 for schedule of no-cost radiation safety training in your area. Outside U.S. – Please contact your local NITON representative for training information

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APPENDIX C

FUMED SLAG ANALYTICAL DATA

May 02, 2005

Iver Johnson

MT DEQ

PO Box 200901

Helena, MT 59620

COPY

RECEIVED

MAY 05 2005

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

Workorder No.: H05040130

Project Name: ASARCO Slag Pile

Energy Laboratories Inc received the following 10 samples from MT DEQ on 4/14/2005 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H05040130-001	ASP01-B3	04/14/05 14:15	04/14/05	Solid	Metals by ICP/ICPMS, Total Mercury in Solid By CVAA Digestion, Total Metals Digestion, Mercury by CVAA
H05040130-002	ASP02-B5	04/14/05 14:21	04/14/05	Solid	Same As Above
H05040130-003	ASP03-B14	04/14/05 14:28	04/14/05	Solid	Metals by ICP/ICPMS, Total Chloride, Sulfate Mercury in Solid By CVAA Moisture Moisture Polychlorinated Biphenyls (PCB's) pH Digestion, Total Metals Digestion, Mercury by CVAA Saturated Paste Extraction Sonication Extraction Soil Sonication Extraction Semi-Volatile Organic Compounds, PAHs Volatile Organics, Methanol Extraction 8260-Volatile Organic Compounds - Short List
H05040130-004	ASP04-C4	04/14/05 14:37	04/14/05	Solid	Metals by ICP/ICPMS, Total Mercury in Solid By CVAA Digestion, Total Metals Digestion, Mercury by CVAA
H05040130-005	ASP05-C9	04/14/05 14:44	04/14/05	Solid	Metals by ICP/ICPMS, Total Chloride, Sulfate Mercury in Solid By CVAA Moisture Moisture Polychlorinated Biphenyls (PCB's) pH Digestion, Total Metals Digestion, Mercury by CVAA Saturated Paste Extraction Sonication Extraction Soil Sonication Extraction Semi-Volatile Organic Compounds, PAHs Volatile Organics, Methanol Extraction 8260-Volatile Organic Compounds - Short List

Metals by ICP/ICPMS, Total
Mercury in Solid By CVAA
Digestion, Total Metals
Digestion, Mercury by CVAA

H05040130-007 ASP07-F3

04/14/05 14:57 04/14/05

Solid

Same As Above

H05040130-008 ASP08-G2

04/14/05 15:04 04/14/05

Solid

Metals by ICP/ICPMS, Total
Chloride, Sulfate
Mercury in Solid By CVAA
Moisture
Moisture
Polychlorinated Biphenyls (PCB's)
pH
Digestion, Total Metals
Digestion, Mercury by CVAA
Saturated Paste Extraction
Sonication Extraction
Soil Sonication Extraction
Semi-Volatile Organic Compounds, PAHs
Volatile Organics, Methanol Extraction
8260-Volatile Organic Compounds - Short List

H05040130-009 ASP09-G4

04/14/05 15:07 04/14/05

Solid

Metals by ICP/ICPMS, Total
Mercury in Solid By CVAA
Digestion, Total Metals
Digestion, Mercury by CVAA

H05040130-010 ASP10-H16

04/14/05 15:15 04/14/05

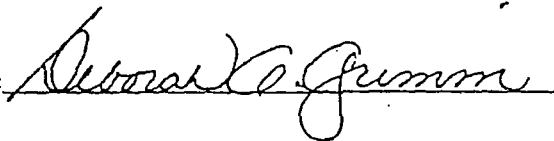
Solid

Same As Above

There were no problems with the analyses and all data for associated QC met EPA or laboratory specifications except where noted in the Case Narrative or Report.

If you have any questions regarding these tests results, please call.

Report Approved By:



Client: MT DEQ
Project: ASARCO Slag Pile
Lab ID: H05040130-001
Client Sample ID: ASP01-B3

Report Date: 05/02/05
Collection Date: 04/14/05 14:15
Date Received: 04/14/05
Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	34.9	mg/kg		5.0		SW6020	04/27/05 00:49 / rth
Arsenic	130	mg/kg		5.0		SW6020	04/27/05 00:49 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 03:48 / jjw
Cadmium	3.1	mg/kg		1.0		SW6010B	04/20/05 19:24 / jjw
Chromium	60.8	mg/kg		5.0		SW6010B	04/20/05 19:24 / jjw
Cobalt	164	mg/kg		5.0		SW6010B	04/20/05 19:24 / jjw
Iron	196000	mg/kg	D	40		SW6010B	04/20/05 19:28 / jjw
Lead	134	mg/kg		5.0		SW6010B	04/20/05 19:28 / jjw
Manganese	11400	mg/kg		5.0		SW6010B	04/22/05 03:48 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 13:51 / KC
Nickel	8.4	mg/kg		5.0		SW6010B	04/20/05 19:24 / jjw
Phosphorus	652	mg/kg		10		SW6010B	04/22/05 03:48 / jjw
Selenium	6.4	mg/kg		5.0		SW6020	04/27/05 00:49 / rth
Zinc	13200	mg/kg		5.0		SW6010B	04/20/05 19:28 / jjw

Report RL - Analyte reporting limit.

Definitions: QCL - Quality control limit.

D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.

ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-002
 Client Sample ID: ASP02-B5

Report Date: 05/02/05
 Collection Date: 04/14/05 14:21
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	46.7	mg/kg		5.0		SW6020	04/27/05 00:56 / rth
Arsenic	135	mg/kg		5.0		SW6020	04/27/05 00:56 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 03:51 / jjw
Cadmium	4.1	mg/kg		1.0		SW6010B	04/20/05 19:32 / jjw
Chromium	59.4	mg/kg		5.0		SW6010B	04/20/05 19:32 / jjw
Cobalt	207	mg/kg		5.0		SW6010B	04/20/05 19:32 / jjw
Iron	243000	mg/kg	D	80		SW6010B	04/22/05 03:51 / jjw
Lead	140	mg/kg		5.0		SW6010B	04/20/05 19:32 / jjw
Manganese	11700	mg/kg		5.0		SW6010B	04/22/05 03:51 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 13:57 / KC
Nickel	20.4	mg/kg		5.0		SW6020	04/27/05 00:56 / rth
Phosphorus	584	mg/kg		10		SW6010B	04/22/05 03:51 / jjw
Selenium	8.5	mg/kg		5.0		SW6020	04/27/05 00:56 / rth
Zinc	16900	mg/kg		5.0		SW6010B	04/22/05 03:51 / jjw

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-003
 Client Sample ID: ASP03-B14

Report Date: 05/02/05
 Collection Date: 04/14/05 14:28
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / B
				RL	QCL		
PHYSICAL CHARACTERISTICS							
Moisture	0.500	wt%		0.0100		SW3550A	04/22/05 08:15 / MC
CHEMICAL CHARACTERISTICS							
pH, 1:2	8.6	s.u.		0.1		ASA10-3	04/25/05 16:18 / srn
Chloride, 1:2	1.99	mg/kg		1.00		ASA10-3	04/26/05 11:49 / qec
METALS, TOTAL							
Antimony	33.7	mg/kg		5.0		SW6020	04/27/05 01:03 / rth
Arsenic	118	mg/kg		5.0		SW6020	04/27/05 01:03 / rth
Beryllium	ND	mg/kg		5.0		SW6010S	04/22/05 04:02 / jjw
Cadmium	2.6	mg/kg		1.0		SW6010S	04/20/05 19:35 / jjw
Chromium	67.1	mg/kg		5.0		SW6010S	04/20/05 19:35 / jjw
Cobalt	117	mg/kg		5.0		SW6010S	04/20/05 19:35 / jjw
Iron	264000	mg/kg	D	80		SW6010S	04/22/05 04:02 / jjw
Lead	63.8	mg/kg		5.0		SW6010S	04/20/05 19:35 / jjw
Manganese	13200	mg/kg		5.0		SW6010S	04/22/05 04:02 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 13:59 / KC
Nickel	14.5	mg/kg		5.0		SW6020	04/27/05 01:03 / rth
Phosphorus	612	mg/kg		10		SW6010S	04/22/05 04:02 / jjw
Selenium	8.4	mg/kg		5.0		SW6020	04/27/05 01:03 / rth
Zinc	13500	mg/kg		5.0		SW6010S	04/22/05 04:02 / jjw
VOLATILE ORGANIC COMPOUNDS							
Bromoform	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Benzene	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Bromobenzene	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Bromochloromethane	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Bromodichloromethane	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Bromomethane	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Carbon tetrachloride	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Chlorobenzene	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Chloroethane	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
2-Chloroethyl vinyl ether	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Chloroform	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Chloromethane	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
2-Chlorotoluene	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
4-Chlorotoluene	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Chlorodibromomethane	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
1,2-Dibromoethane	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
Dibromomethane	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr
1,2-Dichlorobenzene	ND	mg/kg		0.20		SW8260S	04/21/05 16:42 / trr

Report RL - Analyte reporting limit.

Definitions: QCL - Quality control limit.

D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.

ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-003
 Client Sample ID: ASP03-B14

Report Date: 05/02/05
 Collection Date: 04/14/05 14:28
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL		Method	Analysis Date / By
				RL	QCL		
VOLATILE ORGANIC COMPOUNDS							
1,3-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,4-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Dichlorodifluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,2-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
cis-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
trans-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,3-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
2,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
cis-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
trans-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Ethylbenzene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Methyl tert-butyl ether (MTBE)	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Methylene chloride	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Methyl ethyl ketone	ND	mg/kg		4.0		SW8260B	04/21/05 16:42 / trr
Styrene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1,1,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1,2,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Tetrachloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Toluene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1,1-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,1,2-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Trichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Trichlorofluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
1,2,3-Trichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Vinyl chloride	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
m+p-Xylenes	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
o-Xylene	ND	mg/kg		0.20		SW8260B	04/21/05 16:42 / trr
Surr: p-Bromofluorobenzene	134	%REC			76-160	SW8260B	04/21/05 16:42 / trr
Surr: Dibromofluoromethane	116	%REC			70-132	SW8260B	04/21/05 16:42 / trr
Surr: 1,2-Dichloroethane-d4	114	%REC			60-136	SW8260B	04/21/05 16:42 / trr
Surr: Toluene-d8	120	%REC			75-138	SW8260B	04/21/05 16:42 / trr
SEMI-VOLATILE ORGANIC COMPOUNDS							
Acenaphthene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Acenaphthylene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Benzo(a)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-003
 Client Sample ID: ASP03-B14

Report Date: 05/02/05
 Collection Date: 04/14/05 14:28
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / R
				RL	QCL		
SEMI-VOLATILE ORGANIC COMPOUNDS							
Benzo(a)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Benzo(b)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Benzo(g,h,i)perylene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Benzo(k)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Chrysene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Dibenzo(a,h)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Fluorene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Indeno(1,2,3-cd)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Naphthalene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Phenanthrene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 13:56 / sm
Surr: 2-Fluorobiphenyl	82.5	%REC			30-115	SW8270C	04/21/05 13:56 / sm
Surr: Nitrobenzene-d5	83.7	%REC			23-120	SW8270C	04/21/05 13:56 / sm
Surr: Terphenyl-d14	95.6	%REC			15-137	SW8270C	04/21/05 13:56 / sm
POLYCHLORINATED BIPHENYLS (PCB'S)							
Aroclor 1016	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1221	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1232	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1242	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1248	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1254	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1260	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1262	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Aroclor 1268	ND	mg/kg		0.017		SW8022	04/24/05 03:13 / law
Surr: Decachlorobiphenyl	96.0	%REC			50-126	SW8022	04/24/05 03:13 / law
Surr: Tetrachloro-m-xylene	86.0	%REC			42-115	SW8022	04/24/05 03:13 / law

Sample extract received a Sulfuric Acid Clean-up (EPA Method 3665) and a Sulfur Clean-up (EPA Method 3650) prior to analysis

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-004
 Client Sample ID: ASP04-C4

Report Date: 05/02/05
 Collection Date: 04/14/05 14:37
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	43.5	mg/kg		5.0		SW6020	04/27/05 01:10 / rth
Arsenic	155	mg/kg		5.0		SW6020	04/27/05 01:10 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:06 / jjw
Cadmium	5.1	mg/kg		1.0		SW6010B	04/20/05 19:39 / jjw
Chromium	71.2	mg/kg		5.0		SW6010B	04/20/05 19:39 / jjw
Cobalt	212	mg/kg		5.0		SW6010B	04/20/05 19:39 / jjw
Iron	273000	mg/kg	D	80		SW6010B	04/22/05 04:06 / jjw
Lead	364	mg/kg		5.0		SW6010B	04/20/05 19:39 / jjw
Manganese	12200	mg/kg		5.0		SW6010B	04/22/05 04:06 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:01 / KC
Nickel	22.9	mg/kg		5.0		SW6020	04/27/05 01:10 / rth
Phosphorus	586	mg/kg		10		SW6010B	04/22/05 04:06 / jjw
Selenium	12.1	mg/kg		5.0		SW6020	04/27/05 01:10 / rth
Zinc	17900	mg/kg		5.0		SW6010B	04/22/05 04:06 / jjw

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-005
 Client Sample ID: ASP05-C9

Report Date: 05/02/05
 Collection Date: 04/14/05 14:44
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/ RL QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS						
Moisture	0.800	wt%		0.0100	SW3550A	04/22/05 08:15 / MC
CHEMICAL CHARACTERISTICS						
pH, 1:2	9.0	s.u.		0.1	ASA10-3	04/25/05 16:18 / s:m
Chloride, 1:2	2.69	mg/kg		1.00	ASA10-3	04/26/05 12:13 / qed
METALS, TOTAL						
Antimony	37.1	mg/kg		5.0	SW6020	04/27/05 01:44 / rth
Arsenic	117	mg/kg		5.0	SW6020	04/27/05 01:44 / rth
Beryllium	ND	mg/kg		5.0	SW6010B	04/22/05 04:13 / jjw
Cadmium	3.1	mg/kg		1.0	SW6010B	04/20/05 19:42 / jjw
Chromium	74.4	mg/kg		5.0	SW6010B	04/20/05 19:42 / jjw
Cobalt	153	mg/kg		5.0	SW6010S	04/20/05 19:42 / jjw
Iron	252000	mg/kg	D	80	SW5010S	04/22/05 04:13 / jjw
Lead	160	mg/kg		5.0	SW6010S	04/20/05 19:42 / jjw
Manganese	11300	mg/kg		5.0	SW5010S	04/22/05 04:13 / jjw
Mercury	ND	mg/kg		1.0	SW7471A	04/25/05 14:04 / KC
Nickel	15.9	mg/kg		5.0	SW6020	04/27/05 01:44 / rth
Phosphorus	707	mg/kg		10	SW6010S	04/22/05 04:13 / jjw
Selenium	12.7	mg/kg		5.0	SW6020	04/27/05 01:44 / rth
Zinc	18500	mg/kg		5.0	SW6010S	04/22/05 04:13 / jjw
VOLATILE ORGANIC COMPOUNDS						
Bromoform	ND	mg/kg		0.20	SW8250S	04/21/05 17:16 / trr
Benzene	ND	mg/kg		0.20	SW8250E	04/21/05 17:16 / trr
Bromobenzene	ND	mg/kg		0.20	SW8250S	04/21/05 17:16 / trr
Bromochloromethane	ND	mg/kg		0.20	SW8250B	04/21/05 17:16 / trr
Bromodichloromethane	ND	mg/kg		0.20	SW8250S	04/21/05 17:16 / trr
Bromomethane	ND	mg/kg		0.20	SW8250B	04/21/05 17:16 / trr
Carbon tetrachloride	ND	mg/kg		0.20	SW8250B	04/21/05 17:16 / trr
Chlorobenzene	ND	mg/kg		0.20	SW8250B	04/21/05 17:16 / trr
Chloroethane	ND	mg/kg		0.20	SW8250B	04/21/05 17:16 / trr
2-Chloroethyl vinyl ether	ND	mg/kg		0.20	SW8250E	04/21/05 17:16 / trr
Chloroform	ND	mg/kg		0.20	SW8250E	04/21/05 17:16 / trr
Chloromethane	ND	mg/kg		0.20	SW8250E	04/21/05 17:16 / trr
2-Chlorotoluene	ND	mg/kg		0.20	SW8250E	04/21/05 17:16 / trr
4-Chlorotoluene	ND	mg/kg		0.20	SW8250E	04/21/05 17:16 / trr
Chlorodibromomethane	ND	mg/kg		0.20	SW8250B	04/21/05 17:16 / trr
1,2-Dibromoethane	ND	mg/kg		0.20	SW8250E	04/21/05 17:16 / trr
Dibromomethane	ND	mg/kg		0.20	SW8250B	04/21/05 17:16 / trr
1,2-Dichlorobenzene	ND	mg/kg		0.20	SW8250E	04/21/05 17:16 / trr

Report RL - Analyte reporting limit.

Definitions: QCL - Quality control limit.

D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level

ND - Not detected at the reporting limit

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-005
 Client Sample ID: ASP05-C9

Report Date: 05/02/05
 Collection Date: 04/14/05 14:44
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
VOLATILE ORGANIC COMPOUNDS							
1,3-Dichlorobenzene	ND	mg/kg		0.20		SWS260B	04/21/05 17:16 / trr
1,4-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Dichlorodifluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1-Dichloroethane	ND	mg/kg		0.20		SWS260B	04/21/05 17:16 / trr
1,2-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
cis-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
trans-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,3-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
2,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
cis-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
trans-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Ethylbenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Methyl tert-butyl ether (MTBE)	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Methylene chloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Methyl ethyl ketone	ND	mg/kg		4.0		SW8260B	04/21/05 17:16 / trr
Styrene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,1,1,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:15 / trr
1,1,1,2,2-Tetrachloroethane	ND	mg/kg		0.20		SW8250B	04/21/05 17:16 / trr
Tetrachloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Toluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:15 / trr
1,1,1-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:15 / trr
1,1,2-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Trichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:15 / trr
Trichlorofluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
1,2,3-Trichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Vinyl chloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
m+p-Xylenes	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
o-Xylene	ND	mg/kg		0.20		SW8260B	04/21/05 17:16 / trr
Surr: p-Bromofluorobenzene	118	%REC			78-160	SW8260B	04/21/05 17:16 / trr
Surr: Dibromofluoromethane	104	%REC			70-132	SW8260B	04/21/05 17:15 / trr
Surr: 1,2-Dichloroethane-d4	104	%REC			60-136	SW8260B	04/21/05 17:15 / trr
Surr: Toluene-d8	104	%REC			75-138	SW8260B	04/21/05 17:16 / trr
SEMI-VOLATILE ORGANIC COMPOUNDS							
Acenaphthene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Acenaphthylene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Benzo(a)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-005
 Client Sample ID: ASP05-C9

Report Date: 05/02/05
 Collection Date: 04/14/05 14:44
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
SEMI-VOLATILE ORGANIC COMPOUNDS							
Benzo(a)pyrene	ND	mg/kg		0.33		SWS270C	04/21/05 14:39 / sm
Benzo(b)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Benzo(g,h,i)perylene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Benzo(k)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Chrysene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Dibenzo(a,h)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Fluorene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Indeno(1,2,3-cd)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Naphthalene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Phenanthrene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 14:39 / sm
Surr: 2-Fluorobiphenyl	88.6	%REC			30-115	SWS270C	04/21/05 14:39 / sm
Surr: Nitrobenzene-d5	86.9	%REC			23-120	SWS270C	04/21/05 14:39 / sm
Surr: Terphenyl-d14	98.9	%REC			16-137	SW8270C	04/21/05 14:39 / sm
POLYCHLORINATED BIPHENYLS (PCB'S)							
Aroclor 1016	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1221	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1232	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1242	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1248	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1254	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1260	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1262	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Aroclor 1268	ND	mg/kg		0.017		SW8082	04/24/05 03:40 / law
Surr: Decachlorobiphenyl	140	%REC	S		50-126	SW8082	04/24/05 03:40 / law
Surr: Tetrachloro-m-xylene	108	%REC			42-115	SW8082	04/24/05 03:40 / law

Sample extract received a Sulfuric Acid Clean-up (EPA Method 3655) and a Sulfur Clean-up (EPA Method 3660) prior to analysis.

Report
 Definitions: RL - Analyte reporting limit.
 QCL - Quality control limit.
 S - Spike recovery outside of advisory limits.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-006
 Client Sample ID: ASP06-D16

Report Date: 05/02/05
 Collection Date: 04/14/05 14:50
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	42.5	mg/kg		5.0		SW6020	04/27/05 01:51 / rth
Arsenic	130	mg/kg		5.0		SW6020	04/27/05 01:51 / rth
Beryllium	ND	mg/kg		5.0		SW5010B	04/22/05 04:17 / jjw
Cadmium	2.2	mg/kg		1.0		SW6010B	04/20/05 19:46 / jjw
Chromium	68.4	mg/kg		5.0		SW6010B	04/20/05 19:46 / jjw
Cobalt	173	mg/kg		5.0		SW6010B	04/20/05 19:46 / jjw
Iron	305000	mg/kg	D	80		SW6010B	04/22/05 04:17 / jjw
Lead	55.5	mg/kg		5.0		SW6010B	04/20/05 19:46 / jjw
Manganese	11800	mg/kg		5.0		SW6010B	04/22/05 04:17 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:06 / KC
Nickel	18.8	mg/kg		5.0		SW6020	04/27/05 01:51 / rth
Phosphorus	647	mg/kg		10		SW6010B	04/22/05 04:17 / jjw
Selenium	11.0	mg/kg		5.0		SW6020	04/27/05 01:51 / rth
Zinc	19100	mg/kg		5.0		SW5010B	04/22/05 04:17 / jjw

Report RL - Analyte reporting limit.

Definitions: QCL - Quality control limit.

D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.

ND - Not detected at the reporting limit.

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-007
 Client Sample ID: ASP07-F3

Report Date: 05/02/05
 Collection Date: 04/14/05 14:57
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	42.7	mg/kg		5.0		SW6020	04/27/05 01:58 / rth
Arsenic	102	mg/kg		5.0		SW6020	04/27/05 01:58 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:20 / jjw
Cadmium	1.9	mg/kg		1.0		SW6010B	04/20/05 19:49 / jjw
Chromium	70.5	mg/kg		5.0		SW6010B	04/20/05 19:49 / jjw
Cobalt	171	mg/kg		5.0		SW6010B	04/20/05 19:49 / jjw
Iron	286000	mg/kg	D	80		SW6010B	04/22/05 04:20 / jjw
Lead	45.3	mg/kg		5.0		SW6010B	04/20/05 19:49 / jjw
Manganese	12100	mg/kg		5.0		SW6010B	04/22/05 04:20 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:10 / KC
Nickel	17.4	mg/kg		5.0		SW6020	04/27/05 01:58 / rth
Phosphorus	578	mg/kg		10		SW6010B	04/22/05 04:20 / jjw
Selenium	13.8	mg/kg		5.0		SW6020	04/27/05 01:58 / rth
Zinc	19100	mg/kg		5.0		SW6010B	04/22/05 04:20 / jjw

Report Definitions: RL - Analyte reporting limit.
 QCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-008
 Client Sample ID: ASP08-G2

Report Date: 05/02/05
 Collection Date: 04/14/05 15:04
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL		Method	Analysis Date / By
				RL	QCL		
PHYSICAL CHARACTERISTICS							
Moisture	0.800	wt%		0.0100		SW3550A	04/22/05 08:15 / MC
CHEMICAL CHARACTERISTICS							
pH, 1:2	9.2	s.u.		0.1		ASA10-3	04/25/05 16:18 / srm
Chloride, 1:2	1.06	mg/kg		1.00		ASA10-3	04/26/05 12:48 / qed
METALS, TOTAL							
Antimony	43.8	mg/kg		5.0		SW6020	04/27/05 02:05 / rth
Arsenic	119	mg/kg		5.0		SW6020	04/27/05 02:05 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:24 / jjw
Cadmium	2.5	mg/kg		1.0		SW6010B	04/20/05 20:00 / jjw
Chromium	59.6	mg/kg		5.0		SW6010B	04/20/05 20:00 / jjw
Cobalt	194	mg/kg		5.0		SW6010B	04/20/05 20:00 / jjw
Iron	290000	mg/kg	D	80		SW6010B	04/22/05 04:24 / jjw
Lead	116	mg/kg		5.0		SW6010B	04/20/05 20:00 / jjw
Manganese	13100	mg/kg		5.0		SW6010B	04/22/05 04:24 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:12 / KC
Nickel	17.9	mg/kg		5.0		SW6020	04/27/05 02:05 / rth
Phosphorus	720	mg/kg		10		SW6010B	04/22/05 04:24 / jjw
Selenium	9.9	mg/kg		5.0		SW6020	04/27/05 02:05 / rth
Zinc	21100	mg/kg		5.0		SW6010B	04/22/05 04:24 / jjw
VOLATILE ORGANIC COMPOUNDS							
Bromoform	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Benzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Bromobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Bromochloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Bromodichloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Bromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Carbon tetrachloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
2-Chloroethyl vinyl ether	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chloroform	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chloromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
2-Chlorotoluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
4-Chlorotoluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Chlorodibromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2-Dibromoethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Dibromomethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr

Report: RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-008
 Client Sample ID: ASP08-G2

Report Date: 05/02/05
 Collection Date: 04/14/05 15:04
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
VOLATILE ORGANIC COMPOUNDS							
1,3-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,4-Dichlorobenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Dichlorodifluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2-Dichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
cis-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
trans-1,2-Dichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,3-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
2,2-Dichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
cis-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
trans-1,3-Dichloropropene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Ethylbenzene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Methyl tert-butyl ether (MTBE)	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Methylene chloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Methyl ethyl ketone	ND	mg/kg		4.0		SW8260B	04/21/05 17:51 / trr
Styrene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1,1,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1,2,2-Tetrachloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Tetrachloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Toluene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1,1-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,1,2-Trichloroethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Trichloroethene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Trichlorofluoromethane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
1,2,3-Trichloropropane	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Vinyl chloride	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
m+p-Xylenes	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
o-Xylene	ND	mg/kg		0.20		SW8260B	04/21/05 17:51 / trr
Surr: p-Bromofluorobenzene	11E	%REC			76-160	SW8260B	04/21/05 17:51 / trr
Surr: Dibromofluoromethane	10E	%REC			70-132	SW8260B	04/21/05 17:51 / trr
Surr: 1,2-Dichloroethane-d4	10E	%REC			60-135	SW8260B	04/21/05 17:51 / trr
Surr: Toluene-d8	10E	%REC			75-138	SW8260B	04/21/05 17:51 / trr
SEMI-VOLATILE ORGANIC COMPOUNDS							
Acenaphthene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Acenaphthylene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Benzo(a)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-008
 Client Sample ID: ASP08-G2

Report Date: 05/02/05
 Collection Date: 04/14/05 15:04
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
SEMI-VOLATILE ORGANIC COMPOUNDS							
Benzo(a)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Benzo(b)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Benzo(g,h,i)perylene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Benzo(k)fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Chrysene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Dibenzo(a,h)anthracene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Fluoranthene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Fluorene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Indeno(1,2,3-cd)pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Naphthalene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Phenanthrene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Pyrene	ND	mg/kg		0.33		SW8270C	04/21/05 15:21 / sm
Surr: 2-Fluorobiphenyl	75.9	%REC			30-115	SW8270C	04/21/05 15:21 / sm
Surr: Nitrobenzene-d5	76.0	%REC			23-120	SW8270C	04/21/05 15:21 / sm
Surr: Terphenyl-d14	88.9	%REC			18-137	SW8270C	04/21/05 15:21 / sm
POLYCHLORINATED BIPHENYLS (PCB'S)							
Aroclor 1016	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1221	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1232	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1242	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1248	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1254	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1250	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1262	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Aroclor 1268	ND	mg/kg		0.017		SW8082	04/24/05 04:08 / law
Surr: Decachlorobiphenyl	125	%REC			50-126	SW8082	04/24/05 04:08 / law
Surr: Tetrachloro-m-xylene	90.0	%REC			42-115	SW8082	04/24/05 04:08 / law
Sample extract received a Sulfuric Acid Clean-up (EPA Method 3655) and a Sulfur Clean-up (EPA Method 3650) prior to analysis.							

Sample extract received a Sulfuric Acid Clean-up (EPA Method 3655) and a Sulfur Clean-up (EPA Method 3650) prior to analysis.

Report RL - Analyte reporting limit.
 Definitions: QCL - Quality control limit.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

Client: MT DEQ
Project: ASARCO Slag Pile
Lab ID: H05040130-009
Client Sample ID: ASP09-G4

Report Date: 05/02/05
Collection Date: 04/14/05 15:07
Date Received: 04/14/05
Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	57.6	mg/kg		5.0		SW6020	04/27/05 02:12 / rlh
Arsenic	109	mg/kg		5.0		SW6020	04/27/05 02:12 / rlh
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:27 / jjw
Cadmium	1.4	mg/kg		1.0		SW6010B	04/20/05 20:04 / jjw
Chromium	90.0	mg/kg		5.0		SW6010B	04/20/05 20:04 / jjw
Cobalt	204	mg/kg		5.0		SW6010B	04/20/05 20:04 / jjw
Iron	294000	mg/kg	D	80		SW6010B	04/22/05 04:27 / jjw
Lead	64.0	mg/kg		5.0		SW6010B	04/20/05 20:04 / jjw
Manganese	11900	mg/kg		5.0		SW6010B	04/22/05 04:27 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:14 / KC
Nickel	20.6	mg/kg		5.0		SW6020	04/27/05 02:12 / rlh
Phosphorus	562	mg/kg		10		SW6010B	04/22/05 04:27 / jjw
Selenium	12.2	mg/kg		5.0		SW6020	04/27/05 02:12 / rlh
Zinc	20100	mg/kg		5.0		SW6010B	04/22/05 04:27 / jjw

Report Definitions: RL - Analyte reporting limit.
OCL - Quality control limit.
D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
 Project: ASARCO Slag Pile
 Lab ID: H05040130-010
 Client Sample ID: ASP10-H16

Report Date: 05/02/05
 Collection Date: 04/14/05 15:15
 Date Received: 04/14/05
 Matrix: Solid

Analyses	Result	Units	Qual	MCL/		Method	Analysis Date / By
				RL	QCL		
METALS, TOTAL							
Antimony	34.1	mg/kg		5.0		SW6020	04/22/05 05:23 / rth
Arsenic	117	mg/kg		5.0		SW6020	04/22/05 05:23 / rth
Beryllium	ND	mg/kg		5.0		SW6010B	04/22/05 04:31 / jjw
Cadmium	2.1	mg/kg		1.0		SW6010B	04/20/05 20:07 / jjw
Chromium	59.0	mg/kg		5.0		SW6010B	04/20/05 20:07 / jjw
Cobalt	137	mg/kg		5.0		SW6010B	04/20/05 20:07 / jjw
Iron	305000	mg/kg	D	80		SW6010B	04/22/05 04:31 / jjw
Lead	103	mg/kg		5.0		SW6010B	04/20/05 20:07 / jjw
Manganese	10400	mg/kg		5.0		SW6010B	04/22/05 04:31 / jjw
Mercury	ND	mg/kg		1.0		SW7471A	04/25/05 14:16 / KC
Nickel	14.7	mg/kg		5.0		SW6020	04/22/05 05:23 / rth
Phosphorus	710	mg/kg		10		SW6010B	04/22/05 04:31 / jjw
Selenium	9.1	mg/kg		5.0		SW6020	04/22/05 05:23 / rth
Zinc	22200	mg/kg		5.0		SW6010B	04/22/05 04:31 / jjw

Report Definitions: RL - Analyte reporting limit.
 QCL - Quality control limit.
 D - RL increased due to sample matrix interference.

MCL - Maximum contaminant level.
 ND - Not detected at the reporting limit.

APPENDIX 4-1-2

SUMMARY OF SLAG TESTING ANALYSES INCLUDING TEST BASIN WATER QUALITY, SLAG BOTTLE ROLL TESTS AND EP TOXICITY TESTS

OF SOIL-ENTER MONITORING ANALYSES - ASARCO EAST HELENA

SITE NAME	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG	FUMED SLAG
SAMPLE DATE	12/30/84	04/02/87	04/22/87	04/22/87	05/22/87	05/22/87	05/22/87	05/22/87	05/22/87	07/15/87
LAP	ASARCO	ASARCO	ASARCO	CHMTC	ASARCO	ASARCO	CHMTC	CHMTC	CHMTC	ASARCO
REMARKS	BOTTLE			SPLIT	REPLICATE		SPLIT	REPLICATE	REPLICATE	
SAMPLE NUMBER		8704-1	8704-20		8705-50	8705-47			8707-02	8707-01
PHYSICAL PARAMETERS										
WATER TEMPERATURE (C)			7.5			9.7				
SPEC. COND. (UMHOS/CM) FIELD			2235		2268	2265			2137	2150
SPEC. COND. (UMHOS/CM) LAB	115	1950	2250			2320				2400
PH FIELD			6.16		7.48	7.69				7.46
PH LAB	9.9	7.77	6.81			7.52				7.55
TDS MEAS. @ 180 DEG. C	94	1842	1903	993		2086	2227			1912
OXYGEN (O) DISS			4.3			4.3				4.1
DEPTH TO SWL BELOW MP (FT)			8.74			8.01				
COMMON IONS										
CALCIUM (CA)	12	510	454	449.0		422	417.0	412.0		321
MAGNESIUM (MG)	0.49	20	25.5	27.40		20.2	25.10	24.90		22.9
SODIUM (NA)	5.1	76	71.5	76.6		85	72.5	71.8		74
POTASSIUM (K)	3.9	54	65	60.80		74	136.00	122.00		68
BICARBONATE (HCO3) (LAB)	11.0	260	102			98				84
CARBONATE AS CO3 (LAB)	19	11	11			11				11.0
SULFATE (SO4)	10	1450	1425	1240.0		1338	1304.0			1200
CHLORIDE (CL)	18	6.0	7.0	10.0		7.0	30.0			4.0
TRACE ELEMENTS										
ARSENIC (AS) DISS	0.19	0.0325	0.0283	0.0198	0.038	0.030	0.0530	0.0320	0.057	0.039
ARSENIC (AS) +3			0.014						0.0216	0.040
ARSENIC (AS) +5			0.010						0.0722	0.0268
CADMIUM (CD) DISS	0.003	0.075	0.060	0.0720	0.051	0.051	0.0520	0.0500	0.055	0.049
COFFER (CU) DISS	0.009	0.280	0.193	0.2260	0.125	0.128	0.1480	0.1340	0.118	0.110
IRON (FE) DISS	0.11	10.020	10.020	10.100	0.044	0.045	10.100	10.100	10.020	10.020
IRON (FE II)			0.010						0.060	0.080
LEAD (PB) DISS	0.017	0.045	0.030	0.0334	0.019	0.020	0.0323	0.0432	0.016	0.021
MANGANESE (MN) DISS	0.017	1.080	1.440	2.640	1.910	1.930	2.660	2.640	2.930	2.890
ZINC (ZN) DISS	0.023	3.580	3.700	4.450	2.830	2.890	2.840	2.820	2.500	2.300

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 03-19-1987
HW0-6/84-R1

SLAG WATER QUALITY ANALYSES - ASARCO EAST HELENA

SITE NAME	FUMED SLAG	FUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG	UNFUMED SLAG
SAMPLE DATE	02/22/87	02/22/87	12/30/86	04/22/87	04/22/87	05/22/87	05/22/87	07/15/87	09/22/87
LAB	ASARCO	ASARCO	ASARCO	ASARCO	CHMTC	CHMTC	ASARCO	ASARCO	ASARCO
REMARKS	REPLICATE		BOTTLE		SPLIT	SPLIT			
REMARKS			ROLL TEST						
SAMPLE NUMBER	8709-06	8709-04		8704-24			8705-48	8707-03	8709-07
PHYSICAL PARAMETERS									
WATER TEMPERATURE (C)		16 *		10.5			10.9		17 *
SPEC. COND. (UMHOS/CM) FIELD	1368	1366		14296 *			19978	19850	
SPEC. COND. (UMHOS/CM) LAB		1350	200	14500			20200	22000	12200
FH FIELD				9.49			9.97 *	9.48	
FH LAB		7.63	10.4	9.25			9.6	9.73	9.69
TDS MEAS. @ 160 DEG. C		1114	206	14183 *	7298	18720	18523	18172 *	10984
OXYGEN (O) DISS		4.0		4.5			3.2	3.0	4.1
DEPTH TO SWL BELOW MP (FT)		7.74		8.83			7.85		7.02
COMMON IONS									
CALCIUM (CA)		126.5	17	371	437.0		361	426	345
MAGNESIUM (MG)		11	0.22	8.5	8.76		6.7	6.4	4.2
SODIUM (NA)		45	19	2900	2960.0		3890	3800	2200
POTASSIUM (K)		65	22	1950	158.00		2650	2550	1540
ALKALINITY AS CaCO3 (LAB)							587		
BICARBONATE (HCO3) (LAB)		72	(1.0	486 *			(1	(1.0	(1.0
CARBONATE AS CO3 (LAB)		(1.0	36	(1			284	163	197
HYDROXIDE (OH)							38	46	30
SULFATE (SO4)		480 *	16	9200	2480.0	2463.0	1200	11750	6750
CHLORIDE (CL)		3.0	16	57	63.0	75.0	66	74	35
TRACE ELEMENTS									
ARSENIC (AS) DISS	0.075 *	0.054 *	0.31	0.620	0.5130		0.353	0.590 *	0.553
ARSENIC (AS) +3				0.400				0.550	
ARSENIC (AS) +5				0.030				0.054	
CADMIUM (CD) DISS	0.021	0.021	0.003	0.030 *	0.0063		0.003	0.005	0.003
COFFER (CU) DISS	0.055	0.056	0.008	0.130	0.1190		0.128	0.085	0.043
IRON (FE) DISS	(0.020	(0.020	0.070	0.150	(0.190		0.225 *	(0.020	(0.020
IRON (FE II)	0.02	(0.01		(0.010				0.070	(0.01
LEAD (PB) DISS	0.023	0.026	0.083	0.098 *	0.1430		0.0505	0.021 *	0.094
MANGANESE (MN) DISS	1.590	1.540	(0.017	0.155 *	0.139		0.083	0.090	0.050
ZINC (ZN) DISS	0.813	0.788 *	0.053	0.100 *	0.090		0.048	0.030	0.023

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 03-19-1989
HWD-6/AA-F1

TABLE 1
East Helena

SLAG SAMPLE LEACHATE ANALYSIS

1979

979

SARCO

Lab No.

(PPM in Leachate)

Description	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	(Zn)
Slag 1 (2)	.018	.3	.08	<.01	.6	<.001	<.005	<.01	3.5
Slag 2 (2)	<.014	.1	.13	<.01	<.1	<.001	<.005	<.01	2.6
Slag 3 (2)	.020	.1	.03	<.01	3.4	<.001	<.005	<.01	2.1
Slag 4 (2)	<.014	.2	<.01	<.01	<.1	<.001	<.005	<.01	1.0
Slag 5 (2)	.032	.2	<.01	<.01	3.3	<.001	<.005	<.01	5.0
Slag 6 (2)	<.014	.1	.15	<.01	1.0	<.001	<.005	<.01	6.0

Maximum Contaminant
Levels for Non-
toxic Leachates

0.5

10.0

0.1

0.5

0.5

.02

0.1

0.5

NOTE



Currently unspecified but estimated to be 50 ppm (10 times the Drinking Water Standard).

13

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	As ppm	Cd ppm	Pb ppm
3658 Air Cooled	Blast Furnace Slag	5/ 7	.12	.002	5.3
3659 Granulated	Blast Furnace Slag	5/ 7	.047	<.002	.050

ASARCO Inc. Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Ag ppm	As ppm	Ba ppm	Cd ppm	Ci ppm
7860	TCLP-Fumed Blast Furnace Slag	10/21	<.002	.45	4.6	.007	.
7861	TCLP-Unfumed Blast Furnace Slag	10/21	<.002	1.2	1.6	.25	.

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Hg ppb	Pb ppm	Se ppm
7860	TCLP-Fumed Blast Furnace Slag	10/21	<.005	.28	.004
7861	TCLP-Unfumed Blast Furnace Slag	10/21	<.001	10.	.010

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Ag ppm	As ppm	Ba ppm	Cd ppm	
6378	Air Cooled Slag	8/15	<.005	.012	<1.0	.002	
6379	Granulated Slag	8/15	<.005	.010	<1.0	<.002	

ASARCO LAB #	SAMPLE DESCRIPTION	1985 SAMPLE DATE	Hg ppb	Pb ppm	Se ppm	pH	
6378	Air Cooled Slag	8/15	<.50	1.1	<.080	9.2	
6379	Granulated Slag	8/15	<.50	.050	<.080	8.0	

ASARCO Incorporated
Department of Environmental Sciences
EAST HELENA
Miscellaneous Sample Results

ASARCO LAB #	SAMPLE DESCRIPTION	1983 SAMPLE DATE	Pb ppm	Cd ppm	Cr ppm	Ag ppm	Ba ppm
11370	2-4 mo. old Slag Composite	11/28	9.8	3.9	<.030	<.008	7.2
11371	1 week old Slag Composite	11/28	3.9	<.004	<.030	<.008	8.7

ASARCO LAB #	SAMPLE DESCRIPTION	1983 SAMPLE DATE	As ppm	Se ppm	Hg ppb	pH
11370	2-4 mo. old Slag Composite	11/28	.20	.012	<.50	10.
11371	1 week old Slag Composite	11/28	.35	<.004	<.50	10.

ppm

<u>Ba</u>	<u>Pb</u>	<u>Cd</u>	<u>Cr</u>	<u>Ag</u>	<u>Se</u>	<u>Hg</u>	<u>As</u>
-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------

Maximum allowable levels of contaminants
in the leachate of a non-toxic material.....

100. 5.0 1.0 5.0 5.0 1.0 .2 5.0

storage area. The sediments are being stored in a protected environment to prevent contamination of the adjacent area from dispersion of the sediments by wind and water. The sediments are located on a concrete pad to prevent contact with adjacent soils. A containment berm around the perimeter of the sediment pile diverts run-on. A geomembrane cover over the sediments prevents wind and water dispersion and eliminates subsequent generation of leachate.

Approximately 31,000 cubic yards of dewatered sediments were transported to the Lower Ore Storage Area. Four thousand cubic yards of these sediments were smelted prior to the stockpile being covered with a geomembrane liner in October 1997. The sediments will remain in this interim storage facility while EPA considers Asarco's request to modify the sediment smelting requirement of the ROD, and instead dispose of these materials in the on-site CAMU.

4.1.4 Slag

The effect of the slag pile on groundwater and surface water was evaluated as part of the 1990 Comprehensive RI/FS. The evaluation was conducted in accordance with procedures presented in the Comprehensive RI/FS Work Plan (Hydrometrics 1987). Based on the results of the evaluation, the RI/FS concluded that the potential for impacts to groundwater and surface water from slag is low and the subsequent ROD did not specify any remedial action for the Slag Pile Operable Unit. Post-RI/FS monitoring at adjacent surface water and groundwater monitoring sites is on-going. A summary of the slag investigation and the findings of the RI relative to slag are presented below.

4.1.4.1 Investigation of Potential Groundwater Impacts

Slag Infiltration Test Basin Construction, Water Level Measurement, Water Quality Sampling and Analysis

Infiltration and percolation of precipitation into the slag pile were directly measured in slag test basins constructed in fumed and unfumed slag. Fumed slag is a by-product of the zinc

recovery process, which consisted of air injection into molten slag to recover zinc oxide. Unfumed slag is a by-product of the blast furnace which has not been further processed through the zinc recovery process. The zinc recovery process was suspended in 1982 and zinc is no longer recovered from the slag. Since 1982, unfumed slag has been placed in an area segregated from fumed slag.

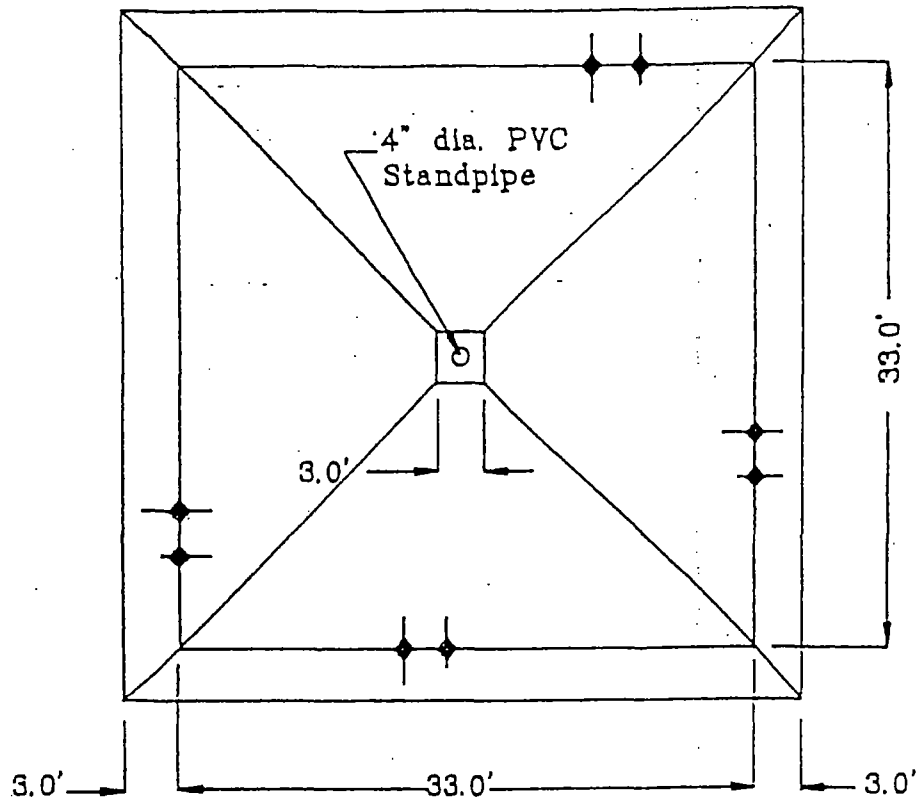
Two slag infiltration catchment basins were constructed; one in a typical location in the fumed slag, and one in a typical location in unfumed slag. Construction of the test basins included removal of a 2 to 3 meter layer of slag, placement of an impervious 36-mil reinforced Hypalon liner in the excavation, installation of a collection sump, and replacement of the slag. Figure 4-1-8 shows the slag test basin design.

Water elevations in the collection sumps were measured periodically, and after rainfall or snowmelt events to determine the actual accumulation of water in the slag basins. Collected water was pumped from the sump, sent to the TSC laboratory, and tested for the parameters listed in Table 3-2-2. Analytical results of water collected in the test basins are summarized in Appendix 4-1-2.

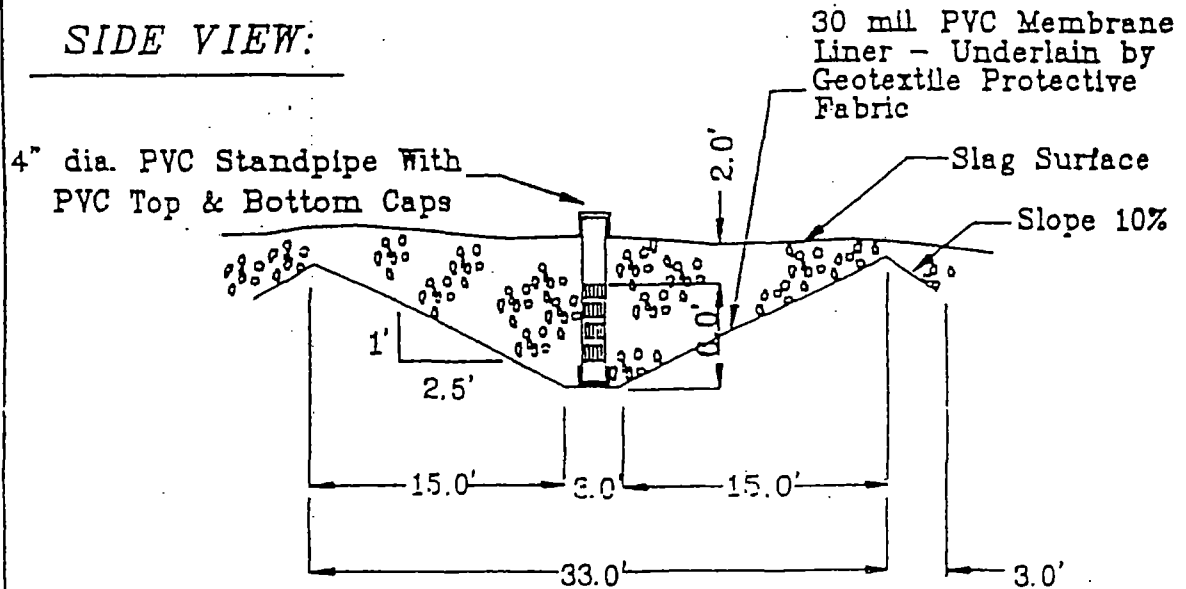
Slag Material Sampling and Analysis

To supplement slag information collected from the test basins, samples of slag were collected from the test basin sites and sent to the TSC lab for "bottle roll" tests. Estimates of slag leachability were obtained by conducting "bottle roll" test on slag samples. Bottle roll tests involved placing samples of slag in bottles in the laboratory, adding deionized water, agitating the bottles for approximately 24 hours, then analyzing the water for concentrations of arsenic and metals. Details of the bottle roll extraction tests are in the Quality Assurance Project Plan (QAPP) Addendum to the Phase II Water Resources Investigation Work Plan (Hydrometries, 1986). Bottle roll test results are in Appendix 4-1-2.

PLAN VIEW:



SIDE VIEW:



NOTE: PVC Standpipe is schedule 40, capped on both ends and perforated with saw-cut slots from 2.0' to 8.0' beneath the slag surface.

In addition to the slag sampling and bottle roll test performed as part of the East Helena RI activities, additional slag samples were collected and analyzed using the EP toxicity procedure. Results of these analyses are also in Appendix 4-1-2.

Assessment of Groundwater Impacts

In an effort to estimate infiltration rates, the volume of water retained in the slag test basins was calculated for 13 time intervals, beginning December 23, 1986 and ending February 10, 1988. These volumes were compared to the volumes of precipitation during the same periods and converted to percentages, as summarized in Table 4-1-10. The percentage of precipitation retained in the basins varied from -6.7% to 61.9% in the fumed slag, and -45% to 61.8% in the unfumed slag (negative percentages indicate evaporation rates exceed precipitation collected in the test basins). Although there is a relationship of test basin water level fluctuations to precipitation (see Figures 4-1-9 and 4-1-10), the relationship may be complicated by variable evaporation, hence, infiltration rates are variable.

Concentrations of arsenic and metals from test basin water samples (see Appendix 4-1-2) were low compared to plant area groundwater. Dissolved arsenic varied from 0.0198 mg/l to 0.075 mg/l in the fumed slag, and 0.353 to 0.590 mg/l in the unfumed slag during the study period. Dissolved cadmium varied from 0.003 to 0.075 mg/l in the fumed slag, and 0.003 to 0.0063 mg/l in the unfumed slag. Dissolved lead varied from 0.016 to 0.045 mg/l in the fumed slag, and 0.021 to 0.098 mg/l in the unfumed slag.

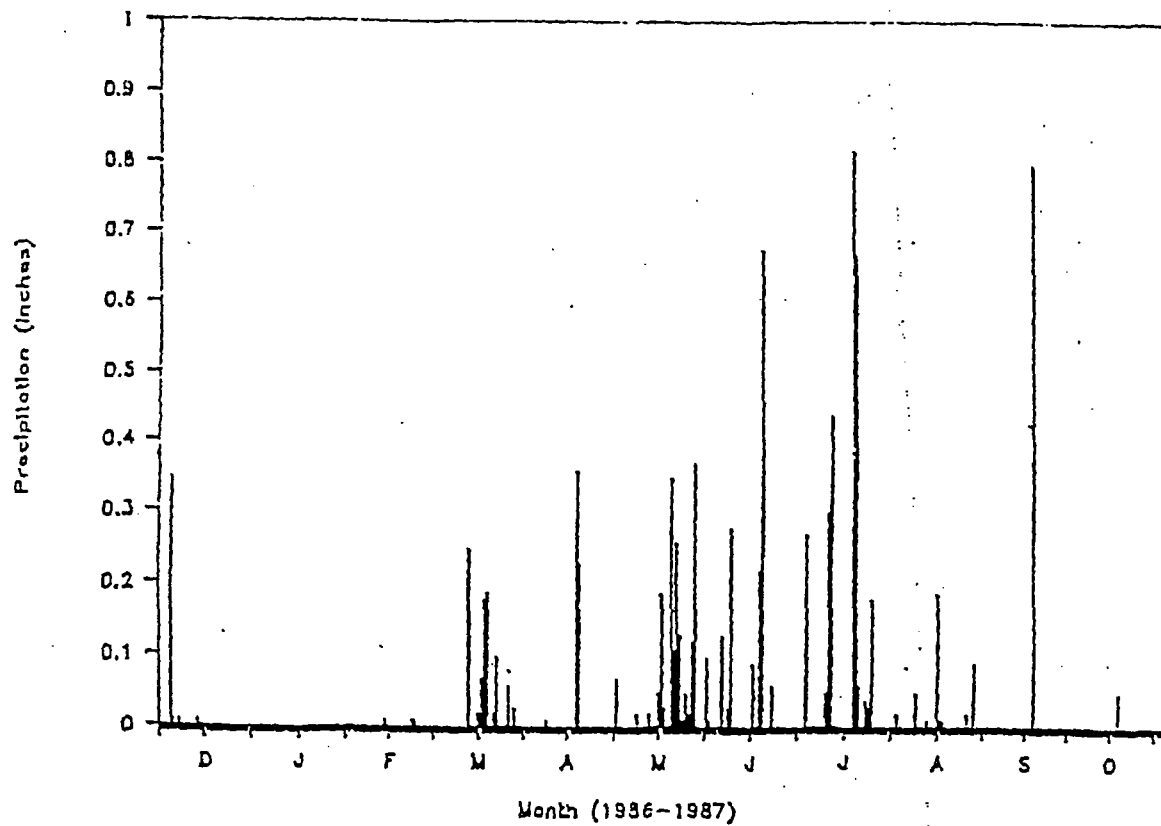
The concentrations of arsenic and metals from bottle roll testing (See Appendix 4-1-2) were similar to the slag test basin water quality. For the fumed slag, dissolved arsenic was 0.19 mg/l, cadmium was 0.003 mg/l, and lead was less than 0.017 mg/l. For the unfumed slag, dissolved arsenic was 0.31 mg/l, cadmium was 0.003 mg/l and lead was 0.083 mg/l.

EP toxicity tests (see Appendix 4-1-2) indicate that leachable trace element concentrations from the slag are variable. From 18 tests, the results for arsenic varied from below detection level to 1.2 ppm with an average of 0.16 ppm; cadmium varied from below detection level to

TABLE 4-1-10. PRECIPITATION COLLECTED IN SLAG TEST BASINS

FUMED SLAG			
Date	Precipitation (inches)	Precipitation Retained *	Percent of Precipitation Retained
12/23/86			
1/22/86	0		
2/23/87	0		
3/26/87	0.75	0.01	1.4
4/21/87	0.23	-0.01	-5.8
5/18/87	0.51	0.32	61.9
6/18/87	2.46	0.49	19.8
7/14/87	0.88	0.25	28.7
8/11/87	1.70	0.36	21.2
9/11/87	0.37	not calculated	
10/14/87	0.65	0.25	38.4
12/7/87	0.45	-0.02	-3.9
1/20/88	0.34	-0.02	-6.7
2/10/88	0.49	-0.01	-1.1
UNFUMED SLAG			
12/23/86			
1/22/87	0		
2/23/87	0		
3/26/87	0.75	0	
4/21/87	0.23	0.12	52.7
5/18/87	0.51	0.27	53.6
6/18/87	2.46	0.73	29.8
7/14/87	0.88	0.28	31.7
8/11/87	1.70	0.12	7.2
9/11/87	0.37	not calculated	
10/14/87	0.65	0.40	61.8
12/7/87	0.45	-0.05	-12.1
1/20/88	0.34	-0.15	-45.0
2/10/88	0.49	0.14	27.6

* Value is calculated based on measured water level changes and test basin geometry (Frustum of a general pyramid). Negative values indicate evaporation exceeds infiltration.

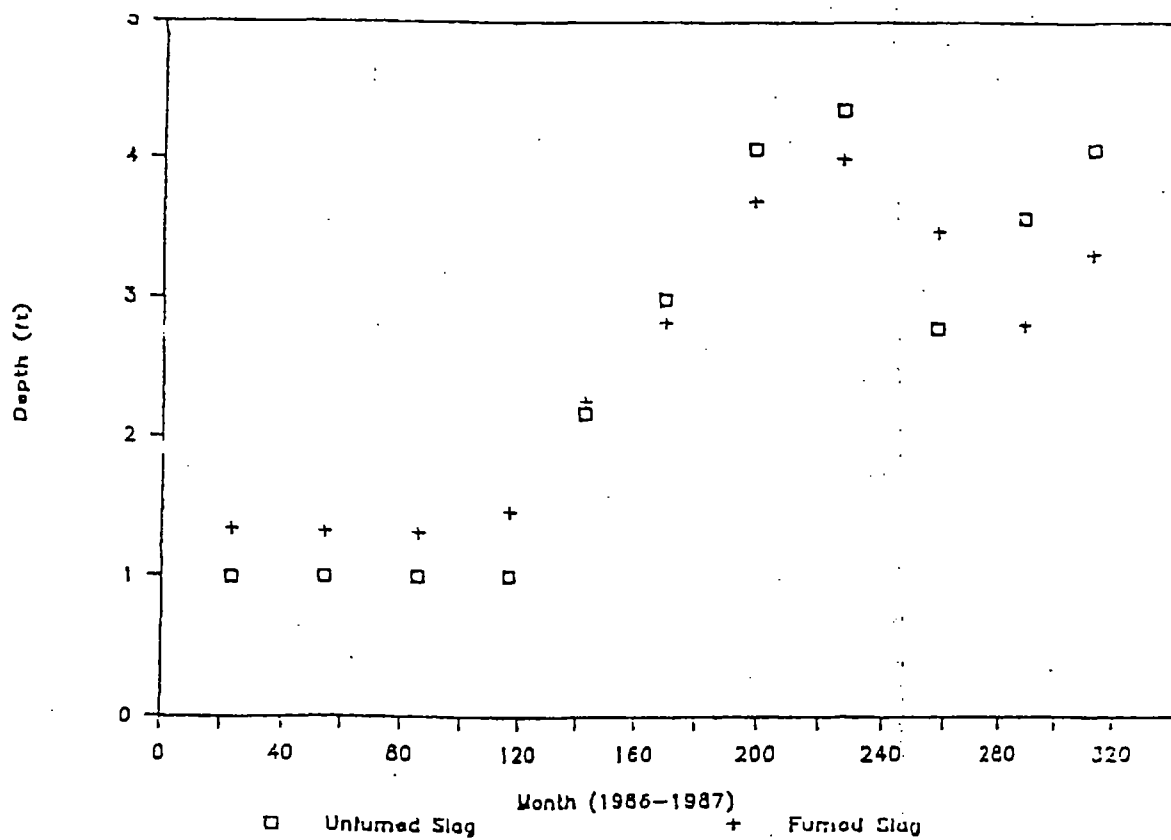


CC/RA REPORT
ASARCO EAST HELENA
FACILITY

DAILY PRECIPITATION
AT HELENA AIRPORT

FIGURE

4-1-9



CC/RA REPORT
ASARCO EAST HELENA
FACILITY

DEPTH OF WATER IN
SLAG TEST BASIN

FIGURE

4-1-10

3.9 ppm, with an average of 0.26 ppm (only one cadmium value was greater than 0.25 ppm; if the 3.9 ppm value is dropped, the cadmium average concentration is 0.04 ppm); lead values varied from below detection level to 30 ppm, with an average of 5.2 ppm.

The EP Toxicity tests were not conducted as part of the Comprehensive RI/FS activities, but have been included as supplementary data. The EP Toxicity results tend to overpredict the mobility of metals compared to the other test results and observed site conditions due to the low pH of the extractant. In particular, the values for lead appear to be much higher with TCLP than with natural conditions.

Concentrations of arsenic and other metals in the groundwater system are discussed in detail in Section 4.4. In general, results of water quality from the slag basins and bottle roll analyses of slag indicate arsenic concentrations are significantly lower than concentrations observed in monitoring wells both upgradient and downgradient of the slag pile. Figures 4-1-11, 4-1-12, 4-1-13 and 4-1-14 show a comparison to slag test basin water quality, bottle roll test water quality, EP Tox test results, and groundwater quality upgradient and down gradient of the slag pile.

Based on observed recharge rates in the slag test basins and associated water quality data, the slag pile would account for only 1 to 3 percent of the observed arsenic at downgradient monitoring well DH-10 (see Figure 4-1-15). Concentrations of arsenic in these wells are similar to arsenic concentrations in DH-4 near Lower Lake, the apparent source of elevated arsenic in these wells. Based on the results of test basin water quality analyses and bottle roll tests, it is unlikely that slag significantly effects observed arsenic concentration trends on the site.

While EP-Toxicity results indicate that there is some potential for mobility of cadmium, lead and zinc from slag, the results of the test basins and bottle roll tests indicate metals concentrations released from slag is low. In addition, concentrations of cadmium, lead and

FIGURE 4-1-12. CADMIUM CONCENTRATION DATA FROM GROUNDWATER MONITORING WELLS IN THE SLAG PILE AREA, AND FROM SLAG TEST BASIN AND SLAG LEACHABILITY TESTING RESULTS

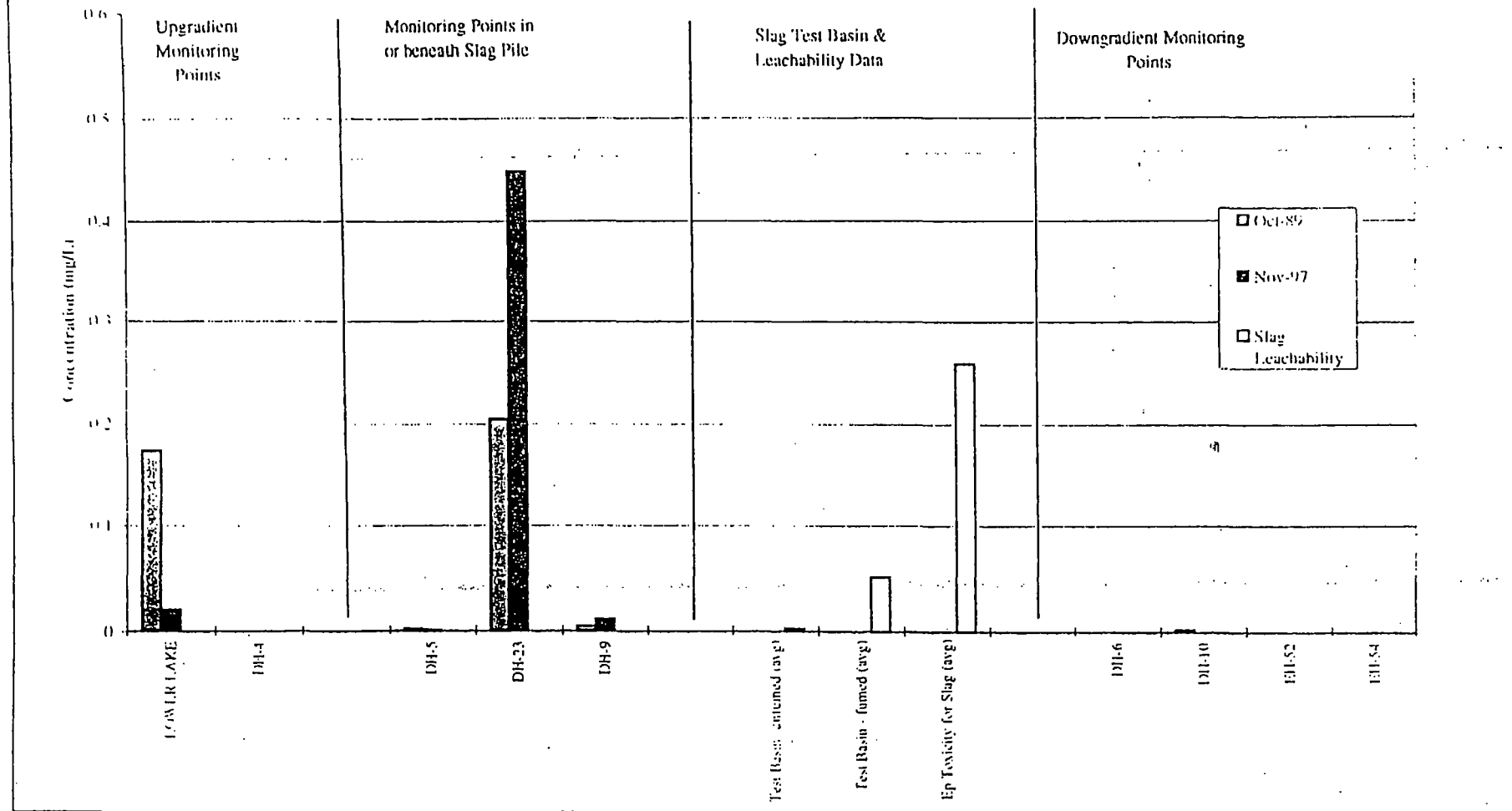
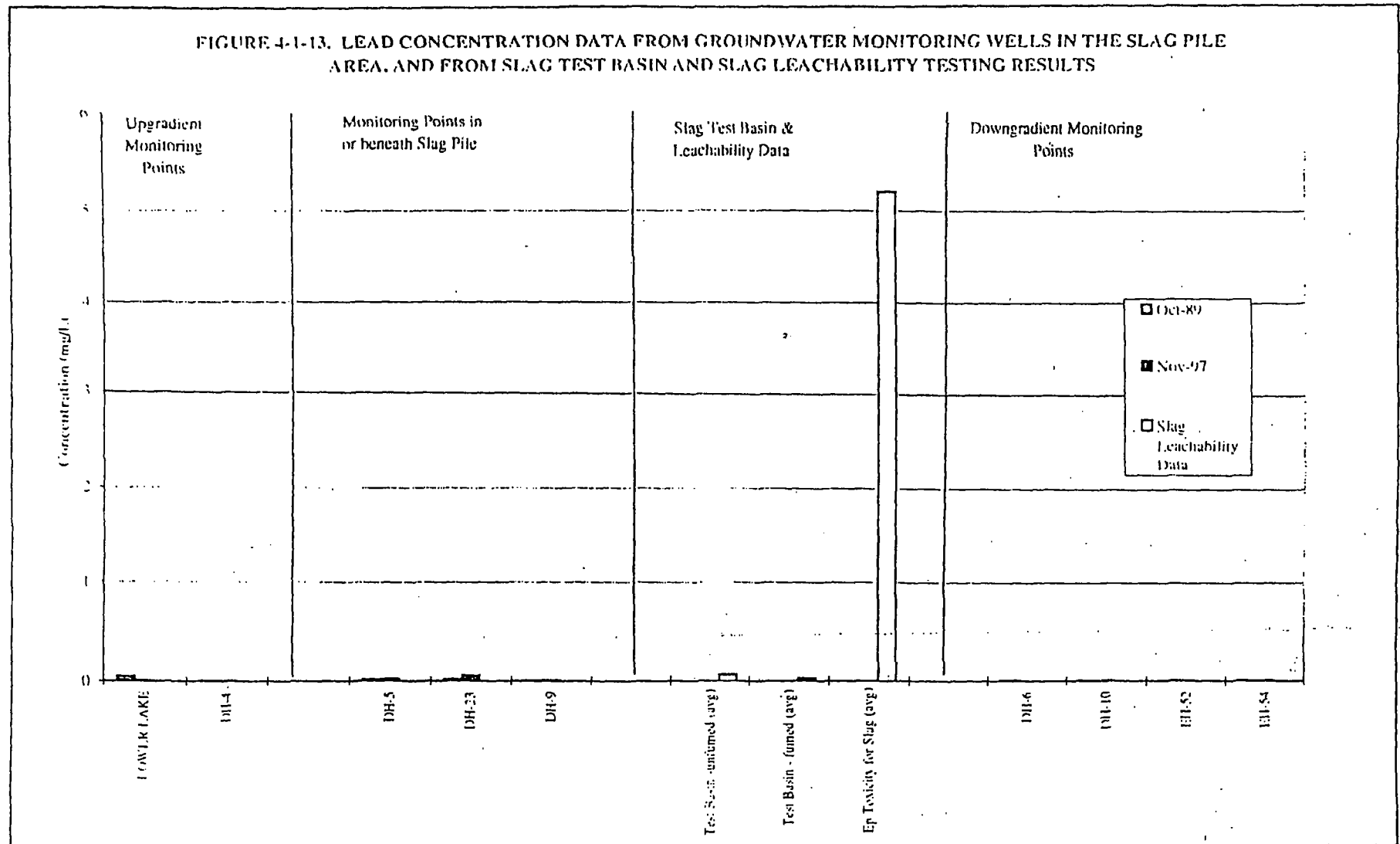
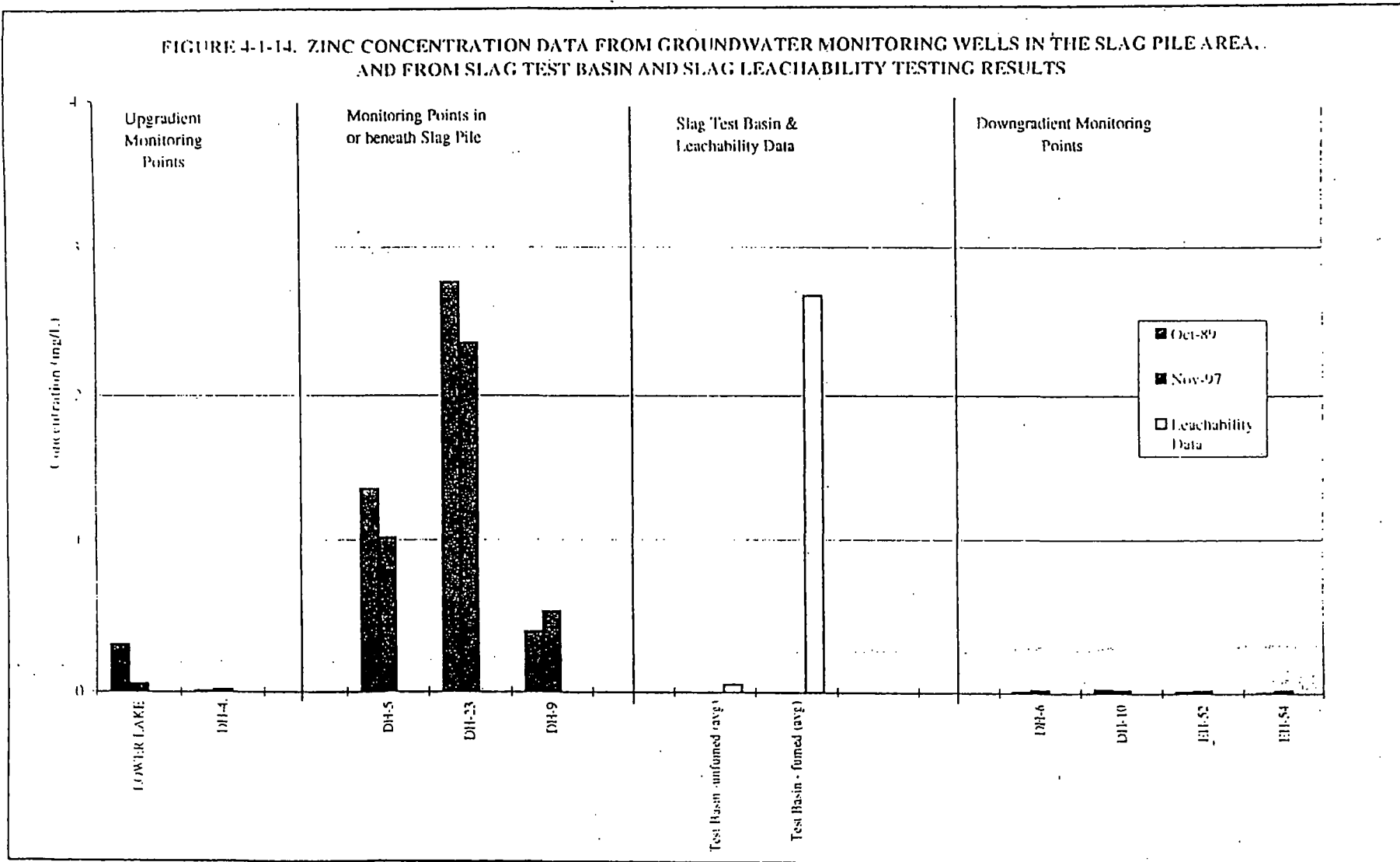


FIGURE 4-1-13. LEAD CONCENTRATION DATA FROM GROUNDWATER MONITORING WELLS IN THE SLAG PILE AREA, AND FROM SLAG TEST BASIN AND SLAG LEACHABILITY TESTING RESULTS





**FIGURE 4-1-15. CALCULATED ARSENIC LOADING FROM SLAG VS
ARSENIC LOAD IN DOWN-GRADIENT GROUNDWATER**

Data Source	Arsenic Conc.(1)	Arsenic Load (2)	% of GW Load (3)
Test Basin Data			
Fumed Slag	0.036 mg/L	0.003 lb/day	0.20%
Unfumed Slag	0.53 mg/L	0.044 lb/day	2.40%
Average	0.28 mg/L	0.022 lb/day	1.30%
Max	0.59 mg/L	0.047 lb/day	2.60%
EP toxicity (avg. of 18 tests)	0.16 mg/L	0.013 lb/day	0.70%
Groundwater Load	2.13 mg/L (4)	1.8 lb/day (4)	

Notes

(1) Source RI/FS Appendix 6-1

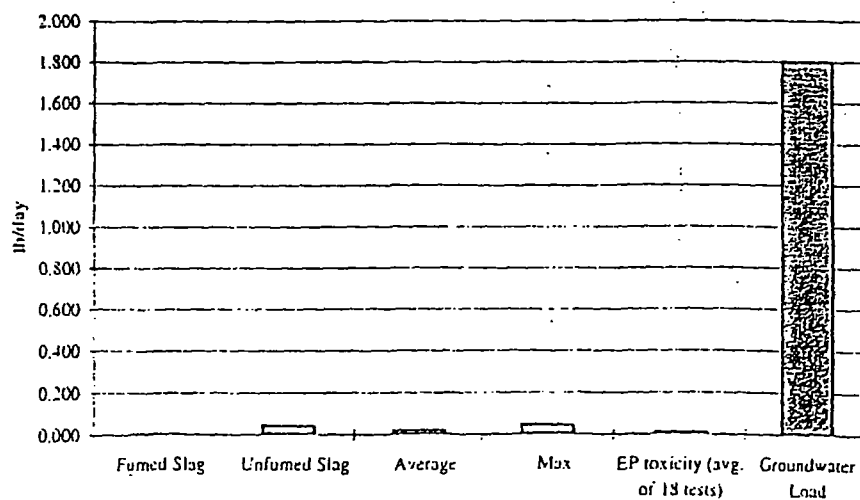
(2) Slag load calculations assume:
20% infiltration (slag test basin average)
11.3 in/yr ppt
57 acre slag pile area

(3) Calculations based on 1.8 lb/day GW arsenic load assuming:
east side groundwater flux of 70 gpm
east side groundwater arsenic concentration of 2.13 mg/L

(4) Groundwater Load assumptions
Groundwater As Concentration 2.13 mg/L (avg from DH-10)
Groundwater flux = 70 gpm

(K:\DATA\PROJECT0867\WQ.XLS)

Arsenic Load



zinc is also very low. Based on the results of test basin water quality analyses, bottle roll tests, and down gradient groundwater quality, it is unlikely that slag effects observed groundwater quality trends on the site.

Stratigraphic cross-sections showing the slag pile and underlying stratigraphy (Figure 4-1-16) shows the relationship of the slag pile and underlying strata, including the perched alluvial horizon and the underlying coarser grained alluvial aquifer. Based on monitoring well stratigraphy, it is likely the perched horizon at least partially underlies the slag pile. However, there is no evidence of the perched horizon in downgradient wells (see DH-6 and DH-10). As a result, direct impacts from the slag pile at these wells is unlikely since the perched horizon is absent, and the wells are completed in the coarse grained alluvium. However, as noted above, test basin and laboratory test results indicate potential water quality impacts from the slag are low and are not responsible for the water quality concentration observed in downgradient wells.

4.1.4.2 Potential Surface Water Impacts

The potential for runoff transport in the slag pile area is very low due to the coarse, granular nature of the slag pile, which allows extremely rapid infiltration. Even during high precipitation events no runoff has been observed from the slag pile. Similarly seeps from the face of the slag pile have not been observed. The potential for impacts to surface water are, therefore, limited to direct contact and erosion of the slag pile where it forms steep sided banks adjacent to Prickly Pear Creek. Prickly Pear Creek is in immediate contact with the slag pile between PPC-5 and PPC-6, and adjacent to the slag pile from PPC-6 to PPC-7 (see Exhibit 3-2-1).

The 1990 Comprehensive RI/FS (Hydrometrics, 1990a) examined water quality data from Prickly Pear Creek to assess the potential impact of the slag pile on the creek. No consistent concentration or load increases were apparent in Prickly Pear Creek adjacent to the slag pile (between PPC-5 and PPC-7). The RI/FS therefore concluded that the contribution of arsenic and metals to surface water from slag is very minor. RI/FS and Post RI/FS water quality data

for Prickly Pear Creek are presented and discussed in Section 4.3 of this report and post-RI/FS water quality data are generally consistent with the RI/FS findings. Average metal concentrations show only small differences between stations PPC 5, PPC 7 and PPC 8 (see Figure 4-1-17). Only one high flow stream event (May 1994) shows a pronounced increase in total arsenic load between PPC-5 and PPC-7 (see Figure 4-3-9 in Section 4.3); however, arsenic concentrations decreased from PPC-5 to PPC-7 in the May 1994 event. The calculated load increase is therefore entirely a function of the flow measurement. Since the accuracy of the flow measurements is poor during higher flow events due to increased velocities and turbulence (particularly at PPC-5 below the dam) the apparent load increase during May 1994 is probably the result of flow measurement error. The conclusion of the surface water analysis is that there is little evidence for transport of arsenic and metals from the slag pile with the possible exception being direct erosion of the slag during infrequent high stream flow events.

4.2.4.2 PROCESS FLUIDS

As part of the Comprehensive RI/FS (Hydrometrics 1990a), the Process Fluids Operable Unit was divided into two sub-units: Process Ponds and Process Fluid Transport Circuits.

4.2.4.2.1 Process Ponds

The Process Ponds include:

- Lower Lake;
- Former Thomock Lake, and
- The acid plant water treatment facility.

As described in Sections 1 and 3, the Process Ponds were addressed by the Process Ponds RI/FS (Hydrometrics, 1989), a subsequent Process Ponds ROD (US EPA, 1989), and several RD/RA documents, and remedial actions that consisted primarily of sediment excavation. The 1989 Process Pond RI consisted of:

ASARCO TECHNICAL SERVICES CENTER

ANALYTICAL DATA REPORT

East Helena

Technical Services (Project 3101)

Batch No: L010790

LAB NO	DATE COLLECTED	DESCRIPTION	PARAMETER	VALUE	UNITS	ANALYST	DATE ANALYZED	HOLD DAYS	METHOD
L010790-002	23-MAY-01	FUMED ASARCO SLAC	AG	0.003	%	MJF	19-JUN-01		ICP
			AL	2.32	%	MJF	18-JUN-01		ICP
			AS	0.022	%	MJF	19-JUN-01		ICP
			BA	0.34	%	MJF	18-JUN-01		ICP
			BE	<0.02	%	MJF	18-JUN-01		ICP
			CR	0.036	%	MJF	18-JUN-01		ICP
			CU	0.32	%	MJF	18-JUN-01		ICP
			HG	2.7	ppm	MO	21-JUN-01		COLD VAPOR AA
			MN	1.37	%	MJF	18-JUN-01		ICP
			NI	<0.02	%	MJF	18-JUN-01		ICP
			PD	0.036	%	MJF	18-JUN-01		ICP
			SD	0.026	%	MJF	18-JUN-01		ICP
			SE	<0.02	%	MJF	18-JUN-01		ICP
			TL	<0.02	%	MJF	18-JUN-01		ICP
			V	<0.02	%	MJF	18-JUN-01		ICP
			Zn	1.63	%	MJF	18-JUN-01		ICP

ASARCO TECHNICAL SERVICES CENTER

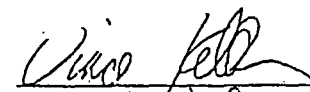
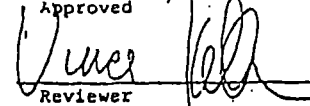
ANALYTICAL DATA REPORT

East Helena

Technical Services (Project 1101)

Batch No: L010791

LAB NO	DATE COLLECTED	DESCRIPTION	PARAMETER	VALUE	UNITS	ANALYST	DATE ANALYZED	HOLD DAYS	METHOD
L010791-002	23-MAY-01	FUMED ASARCO SLAG (TCLP)	AG	<0.050	ppm	ESH	08-JUN-01	6010	
			AS	<0.10	ppm	ESH	08-JUN-01	6010	
			BA	1.4	ppm	ESH	08-JUN-01	6010	
			BE	<0.005	ppm	ESH	08-JUN-01	6010	
			CD	<0.050	ppm	ESH	08-JUN-01	6010	
			CR	<0.10	ppm	ESH	08-JUN-01	6010	
			HC	<0.50	ppb	MO	07-JUN-01	7470	
			NI	<0.10	ppm	ESH	08-JUN-01	6010	
			PB	0.23	ppm	ESH	08-JUN-01	6010	
			PH	9.2	pH	MO	05-JUN-01	150.1	
			SE	<0.10	ppm	ESH	08-JUN-01	6010	
			TL	<0.10	ppm	ESH	08-JUN-01	6010	
			V	<0.10	ppm	ESH	08-JUN-01	6010	
			ZN	17	ppm	ESH	08-JUN-01	6010	


 Approved

 Reviewer

APPENDIX D

TEMPORARY CAP SPECIFICATIONS AND DETAILS

INSTALLATION SPECIFICATION —RPE® GEOMEMBRANE

PART 1 – GENERAL

1.1 SCOPE

- A. The work covered by this specification consists of the supply (and installation) of an RPE geomembrane at the locations shown on the drawings (as directed by the Owner).
- B. The supply (and installation) of this liner shall be in accordance with the following references:
 - 1. ASTM D751-89, Standard Test Methods for Coated Fabrics.
 - 2. ASTM D3020-89, Standard Specification for Polyethylene and Ethylene Copolymer Plastic Sheeting for Pond, Canal, and Reservoir Lining.
 - 3. ASTM D4545-86(91), Standard Practice for Determining the Integrity of Factory Seams Used in Joining Manufactured Flexible Sheet Geomembranes.

PART 2 – PRODUCTS

2.1 MATERIAL CHARACTERISTICS

- A. The sheeting shall be suitably formulated from first quality polyethylene materials. The geomembrane shall consist of a high strength, oriented-tape HDPE scrim coated on both sides with an impervious LDPE coating (HDPE coating for OR RPE 25). RPE materials prepared for temporary covers or other exposed application will have UV stabilizers added to the impervious coating (and may have UV stabilizers added to the scrim tapes). The RPE material shall be pigmented to produce a uniform color such as black, blue, or silver. Unpigmented materials may be used for applications that are backfilled.
- B. The sheeting shall be capable of being sealed to itself using a stitched “Z” fold or heat-sealing techniques.
- C. The sheeting shall be supplied in the widest widths possible to minimize fabrication seaming. Roll widths shall be not less than 3.5 m.

2.2 MANUFACTURER’S STATEMENT

- A. Upon request, the manufacturer of the RPE sheeting shall submit a certification that the material meets the manufacturer’s specifications. Material index quality control tests shall be performed a minimum of every 18,000 kg (40,000 lbs), once per shift, or at the start of a new material run.

2.3 MATERIAL PROPERTIES

- A. The geomembrane shall be OR RPE 25 as supplied by Layfield Plastics or an approved equal. The geomembrane shall conform to the manufacturer’s material properties table. All values are Typical Values unless otherwise noted.

2.4 WARRANTY

- A. Contractor shall provide Owner with a warranty guaranteeing a minimum of three year satisfactory liner performance from defects and UV-degradation.

PART 3 – EXECUTION

3.1 FABRICATION

- A. On all projects larger than 20,000 m² (200,000 ft²), submit a panel layout in accordance with the project submittal requirements. On the panel layout, indicate the proposed arrangement of panels, fabricated seam orientation, field seam location, and anchor trench locations.
- B. Individual roll widths of RPE shall be fabricated into large panels to minimize field seaming. All fabrication welds shall be a minimum of 25 mm (1 inch) wide. Heat welding techniques shall be used for shop fabrication such that all shop welds will provide a delamination of the coating from the scrim when tested. Peel testing will meet the requirements for a "Film Tear Bond" (FTB) Peel Adhesion. The minimum FTB rating shall be AD-DEL.
- C. Fabrication welding shall be tested for Bonded Seam strength at a rate of three samples for every 915 lineal meters (3,000 ft) of welded seam. At the fabricator's option, one sample may be taken from each 300 lineal meters (1,000 ft) of welded seam or every 5 shop seams (whichever is greater). Seam samples will be tested for shear strength. Fabricated seam strengths shall conform to the shop seam strength values. Seams samples shall also be qualitatively tested for peel adhesion with a Film Tear Bond rating being obtained on all seams. Seams that do not meet the strength or FTB criteria are to be repaired and retested.
- D. Fabricated panels shall be accordion folded in one direction and neatly rolled in the other. Each panel shall be protected with an opaque, weather resistant covering and marked with panel dimensions and unfolding directions. All panels shall be delivered and stored in a protected area until ready for installation.

3.2 INSTALLATION

- A. Prepared surfaces shall be smooth and free of sharp objects, rocks, and organics (roots). If a suitable subgrade is not available then 100 mm (4 inches) of clean sand, and a 10 ounce geotextile shall be placed prior to liner installation (subject to site conditions). A 10 ounce geotextile shall be placed under the liner in all areas.
- B. Installation shall be performed in a logical sequence by an installer/contractor experienced in lining installations.
- C. Place panels according to the drawings and the panel layout. Sufficient thermal slack shall be incorporated during placement to ensure that harmful stresses do not occur in service. Distribute slack wrinkles evenly.
- D. All field seams shall be tightly bonded using tape seaming technology. Six inch wide polyisobutylene-butyl sealant tape shall be used at penetrations and for all field seams.
- E. Full contact between the tape and the material will be the standard of acceptance.
- F. All field seams shall be non-destructively tested along their entire length using the Air Lance Test (ASTM D4545) or the Mechanical Point Stress Test (ASTM D4545). Patches and seams around pipe penetrations and fitments shall be tested using the Point Stress Test (ASTM D4545). All discontinuities detected by any test method shall be repaired.
- G. Repairs shall utilize the same material as the geomembrane, or a material compatible with the geomembrane, and shall extend a minimum of 300 mm (12 inches) beyond the defect. Repairs shall be accomplished with tape seaming techniques utilizing a tape appropriate to existing site conditions. All repairs are to be tested using Air Lance or Mechanical Point Stress methods as applicable (ASTM D4545).

- H. Protect the geomembrane from wind uplift during installation through the use of sand bags or other suitable weights. Backfill anchor trenches and place design backfill on geomembrane as soon as practical. Placement of backfill should be monitored continuously, and any damaged areas repaired and tested.
- I. Shingle RPE seams in the direction of water flow as applicable. If possible, backfill in the direction of flow to prevent application of stresses to field seams.
- J. Pipe Boots. Fit and seal pipes, well casings, manholes, and other penetrations of the geomembrane with shop fabricated boots as shown on the Drawings. Match the flange portion of the boot to the angle of the slope or bottom where the pipe or manhole enters the liner for a smooth fit without excess stretching of the material.

END OF SECTION

CLARIFICATIONS FOR TEMPORARY CAP DESIGN

Clarification #1 - RPE® Geomembrane

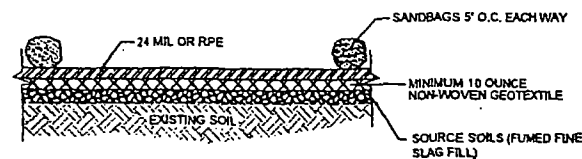
The clarification for the conflict between Note 4 on Hydrometrics Sheet 16 and the Installation Specification —RPE® Geomembrane of this Appendix C regarding the seaming requirements is that seams shall be sewn. Note 4 on Sheet 16 states that the seams must be sewn. The Installation Specification – RPE Geomembrane states that the seams can be either sewn or taped. This clarification states that for the construction of the Temporary Cap at the former Speiss-Dross Plant area, the RPE geomembrane seams shall be sewn and taping will not be allowed.

Clarification #2 – Clean Sand Substitute

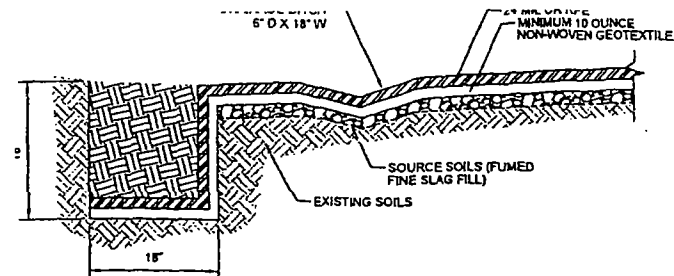
Slag may be substituted for clean sand for subgrade preparation as specific in the Installation Specification —RPE® Geomembrane, Paragraph 3.2 (A).

Clarification #3 – Final Grade Flow Pattern

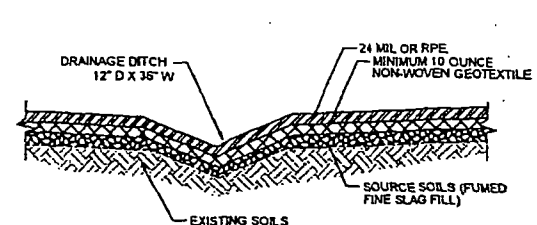
The importance of the final grade flow pattern will be discussed in further detail at the pre-bid conference.



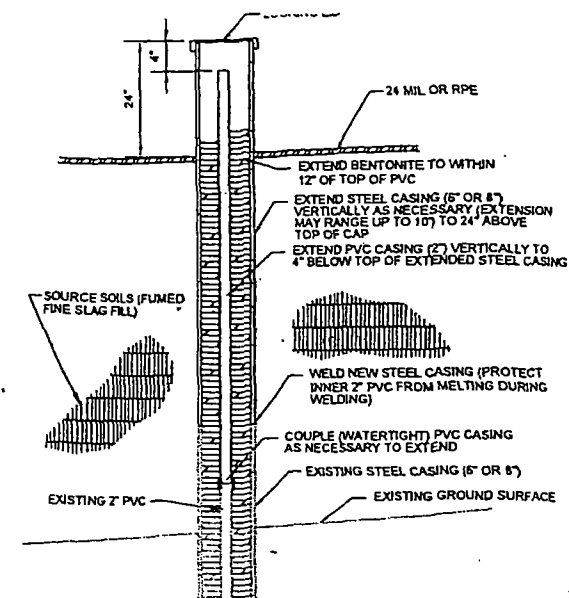
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TEMP CAP
SCALE: NTS



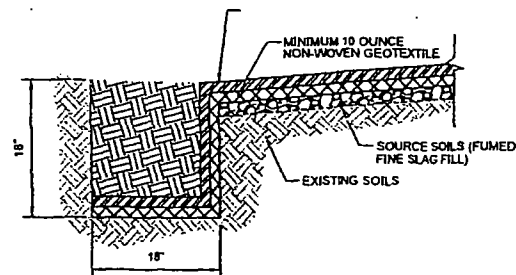
2 DETAIL
LINER ANCHOR TRENCH WITH DRAINAGE DITCH
SCALE: NTS



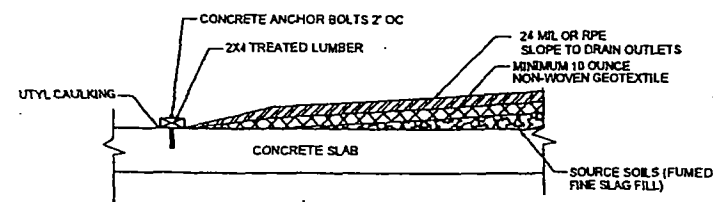
3 DETAIL
LINER DRAINAGE DITCH (TYP)
SCALE: NTS



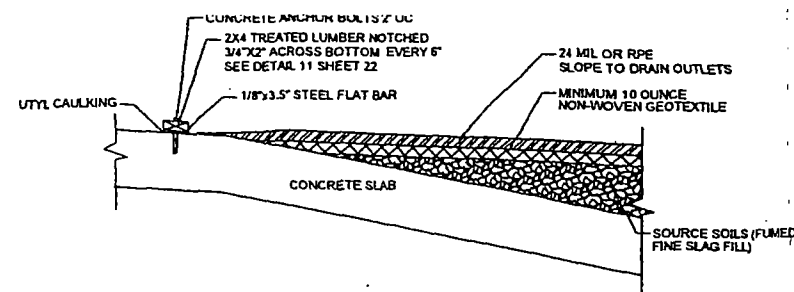
10 DETAIL
MONITORING WELL EXTENSION
SCALE: NTS



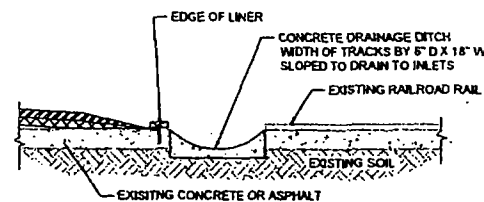
4 DETAIL
LINER ANCHOR TRENCH
SCALE: NTS



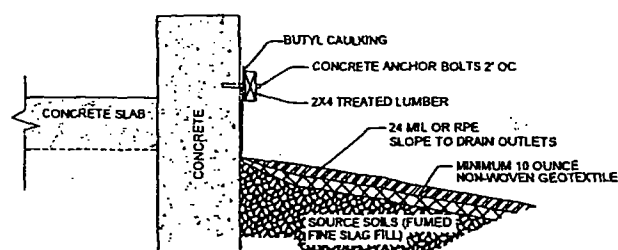
5 DETAIL
LINER CONCRETE ANCHOR
SCALE: NTS



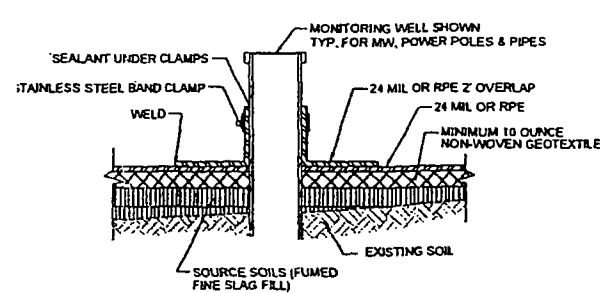
6 DETAIL
RUN-ON LINER/CONCRETE ANCHOR
SCALE: NTS



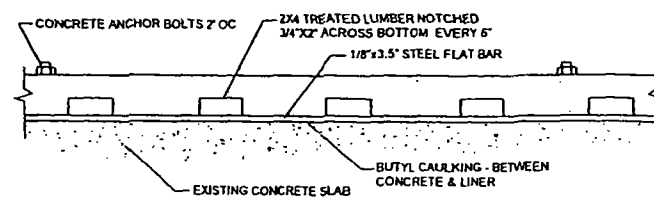
7 DETAIL
CONCRETE DRAINAGE DITCH
SCALE: NTS



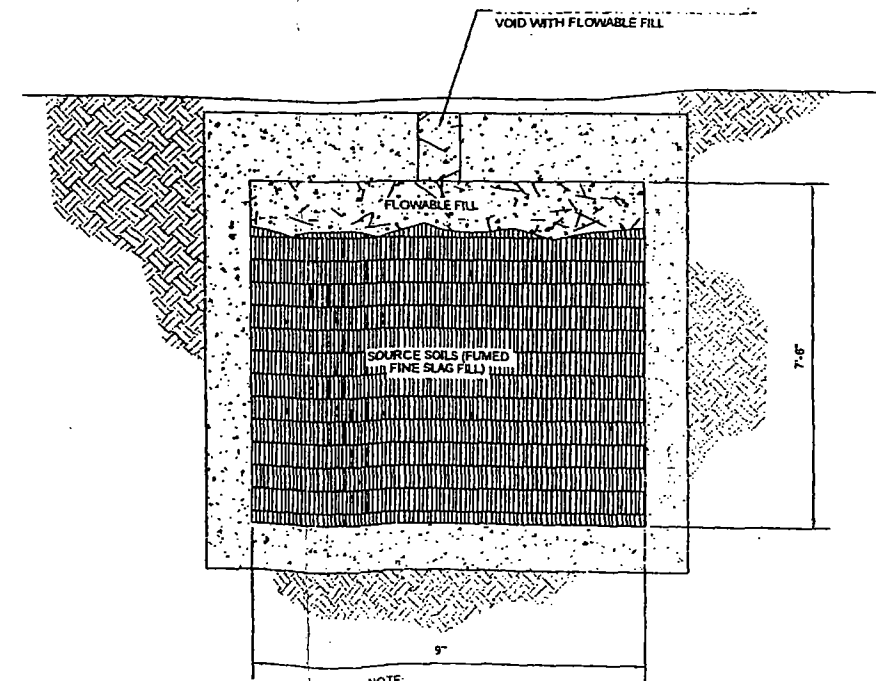
8 DETAIL
LINER WALL/FOUNDATION ANCHOR
SCALE: NTS



9 DETAIL
PROTRUSION & LINER CONNECTION (TYP)
SCALE: NTS



11 DETAIL
RUN-ON ANCHOR DETAIL
SCALE: NTS



NOTE: TUNNEL LENGTH IS 42'.
SECTION A TUNNEL DETAIL
SCALE: NTS

NO	BY	DATE	DESCRIPTION	NO	BY	DATE	DESCRIPTION
1	JSD	022607	REVISION TO DETAIL 7 FOR CLARITY. DETAIL 8 TEXT EDIT IN TITLE				
				SCALE VERIFICATION	Project No.	6052	
				BAR IS ONE INCH ON ORIGINAL DRAWING	DRAWN BY	JSD	111907
				0 1	CHECKED BY	JMD	112907
				IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	APPROVED BY	JMD	112407
					SCALE:	AS NOTED	

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana 59601
2020 Business Avenue
(408) 443-4180

ASARCO LLC - EAST HELENA PLANT
2007 CLEANING & DEMOLITION PROJECT
DETAILS

DRAWING FILE NUMBER
605202H022.dwg
AUTOCAD 2004 DRAWING (DWG)
SHEET NUMBER
22

APPENDIX E

EXAMPLE INSPECTION FORM

INTERIM CAP INSPECTION CHECKLIST

AREA INSPECTED	Area No.		Inspected by:	DATE:		
	ITEM NO.	CONDITION	OBSERVATION	ACTION NEEDED		
				MONITOR	INVESTIGATE	REPAIR
INTERIM LINER SYSTEMS	1	Exposed liner				
	2	Sand Bags				
	3	Liner Seams				
	4	Liner/Concrete Attachments				
	5	Site Drainage				
Additional Comments:						